# 3.3.1.10 Historical, Archaeological and Cultural Resources

By the end of Fiscal Year 1992, approximately 60 percent of the 800 km<sup>2</sup> (310 m<sup>2</sup>) of the Savannah River Site had been examined, and 858 archaeological sites had been identified. Of these, 53 have been determined to be eligible for the National Register of Historic Places, and 650 have not been evaluated (DOE, 1995c).

Three Native American groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, have expressed concerns over sites and items of religious significance on the Savannah River Site.

Archaeologists have divided areas of the Savannah River Site into three sensitivity zones related to their potential for containing sites with multiple archaeological components or dense or diverse artifacts, and their potential for eligibility to the National Register of Historic Places (DOE, 1995c).

Zone One is the zone of highest archaeological site density, with a high probability of encountering large archaeological sites with dense and diverse artifacts, and high potential for nomination to the National Register of Historic Places. Zone Two covers areas of moderate archaeological site density that should contain sites of similar composition. Activities in this zone have a moderate probability of encountering archaeological sites, but a low probability of encountering large sites with more than three prehistoric components. All areas within the zone are conducive to site preservation. The zone has moderate potential for encountering sites that would be eligible for nomination to the National Register of Historic Places. Zone Three covers areas of low archaeological site density. Activities in this zone have a low probability of encountering archaeological sites and virtually no chance of encountering large sites with more than three prehistoric components. Therefore, potential for site preservation is low. Some exceptions to this definition have been discovered in Zone 3, so some sites in the zone could be considered eligible for nomination to the National Register of Historic Places.

## 3.3.2 Description of the Affected Environment at the Idaho National Engineering Laboratory

This section describes the potentially affected environment of the Idaho National Engineering Laboratory. The location of the site is shown in Figure 3-52.

## 3.3.2.1 **Geology**

The Idaho National Engineering Laboratory is located within a broad low-relief basin floored with basaltic lava flows and terrestrial sediments in the Eastern Snake River Plain physiographic province. The Snake River Plain extends in a broad arc from the Idaho-Oregon border in the west to the Yellowstone Plateau in the east, and contrasts sharply with the surrounding mountainous country of the Northern Basin and Range Province and the Idaho Batholith.

The Snake River Plain was formed in response to the movement of the North American Continent over a deep seated plume of hot mantle rocks. Movement of the continent and a northeast directed extension of the crust caused development of both the Eastern Snake River Plain and the northern Basin and Range Province over the past 17 million years. This movement has produced northwest trending normal faults in the Basin and Range Province and volcanic activity, including the formation of calderas, rhyolite domes, and volcanic rifts or vents.

Surface rocks on and near the Idaho National Engineering Laboratory are mostly an interlayered sequence of basalt flows and poorly consolidated sedimentary interbeds to a depth of 1 to 2 km (0.6 to 1.2 mi). Interbedded sediments are composed mostly of fine-grained silts and clays. A wide band of Quaternary

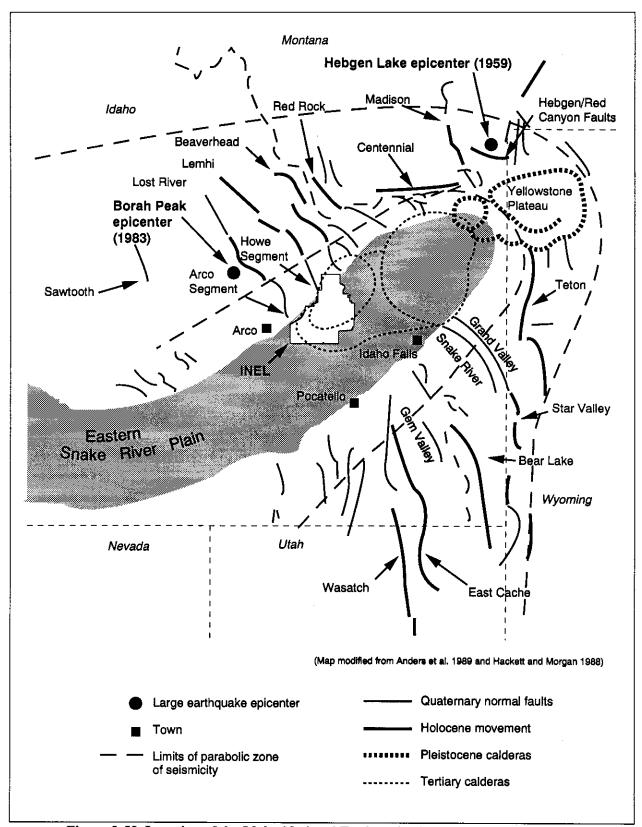


Figure 3-52 Location of the Idaho National Engineering Laboratory in Context of Regional Geologic Features

mainstream alluvium extends along the course of the Big Lost River (southwestern corner of the Idaho National Engineering Laboratory) to the Lost River Sinks area in the north-central portion of the Idaho National Engineering Laboratory. Lacustrine clay and sand deposits from the Ice Age Lake Terreton occur in the northern part of the site. Some of these beach sands were reworked by winds in late Pleistocene and Holocene times to form large dune fields in the northeastern part of the Idaho National Engineering Laboratory (Scott, 1982). Several Quaternary rhyolite domes occur along the Axial Volcanic Zone near the south and southeast borders of the Idaho National Engineering Laboratory. Paleozoic limestones, late-Tertiary rhyolitic volcanic rocks, and large alluvial fans occur in limited areas along the northwest margin of the site.

# 3.3.2.2 Seismology and Volcanology

The effusion of basaltic-lava flows from volcanic rift zones has been the predominant style of volcanism on the Eastern Snake River Plain, including the Idaho National Engineering Laboratory area, during the past 4 million years. Broad uplift of the ground surface, together with the opening of fissures and faults, accompany the ascending magma before eruptions. Vents for the basaltic volcanism are concentrated in northwest-trending volcanic rift zones and along the Axial Volcanic Zone (Kuntz, 1992).

Volcanic vents on the Eastern Snake River Plain are concentrated in several linear belts that trend northwest and northeast. These northwest-trending belts are associated with ground deformation features referred to as volcanic rift zones with fissures, faults, grabens, and monoclines. Volcanic vents are also concentrated in a northeast-trending zone along the axis of the Eastern Snake River Plain, called the Axial Volcanic Zone to distinguish it from volcanic rift zones (Hackett and Smith, 1992). Basaltic-lava eruptions appear to have been most frequent and most recent (approximately 5,200 years ago at Hell's Half Acre) along this zone, and at intersections of that zone with northwest-trending volcanic rift zones in the site area. Volcanic vents in this area are fed by northwest-trending dikes with seismicity associated with volcanism.

The Eastern Snake River Plain is surrounded by the seismically active Intermountain Seismic and Centennial Tectonic Belts (Smith and Arabasz, 1991). The Snake River Plain is devoid of earthquakes relative to the active areas surrounding it. The Eastern Snake River Plain has exhibited infrequently-occurring small magnitude (M 1.5) earthquakes.

#### 3.3.2.3 Hydrology

#### 3.3.2.3.1 Surface Water

Surface water at the Idaho National Engineering Laboratory accumulates into streams from local rainfall, snowmelt, and runoff originating in the mountain ranges located directly north and west of the Idaho National Engineering Laboratory. Surface water also includes water contained in man-made infiltration and evaporation ponds. Except for standing water in man-made ponds, there is little surface water at the Idaho National Engineering Laboratory. However, during wet years, when runoff from drainage basins or snowmelt is heavy, surface water bodies are formed.

The Idaho National Engineering Laboratory is located in Pioneer Basin, a closed drainage basin that includes three main surface water bodies: The Big Lost River, the Little Lost River, and Birch Creek. These sources of water drain mountain watersheds located north and west of the Idaho National Engineering Laboratory. However, most of the surface water flow is diverted for irrigation before it

reaches site boundaries (Barraclough et al., 1981). This has resulted in little or no flow in these surface water bodies for several years within the boundaries of the Idaho National Engineering Laboratory (Pittman et al., 1988).

The Big Lost River is the major surface water body at the Idaho National Engineering Laboratory. The river flows between the Lost River Range and the Pioneer Mountains, draining approximately 3,755 km<sup>2</sup> (1,450 mi<sup>2</sup>) of land before reaching the site. Approximately 48 km (30 mi) upstream of Arco, ID, Mackay Dam controls and regulates the flow of the river. During heavy runoff events, surface water from the Big Lost River is diverted to four spreading areas located south of the Idaho National Engineering Laboratory Diversion Dam. North of the diversion dam, the Big Lost River continues northward across the site to an area of natural infiltration basins (playas or sinks) near Test Area North. Flow within the Big Lost River channel may only reach a few kilometers southeast of Arco during drought years.

Birch Creek flows through an elongated, southeast-trending valley located between the Lemhi and Beaverhead Mountain Ranges, which cross the northwest corner of the Idaho National Engineering Laboratory to Playa 4 near Test Area North. Birch Creek drains an area of approximately 1,943 km<sup>2</sup> (750 mi<sup>2</sup>). In the summer, upstream of the Idaho National Engineering Laboratory, surface water from Birch Creek is diverted for irrigation and to produce hydropower. In the winter, water flows in a man-made channel constructed 6.4 km (4 mi) north of Test Area North, where it infiltrates into channel gravel.

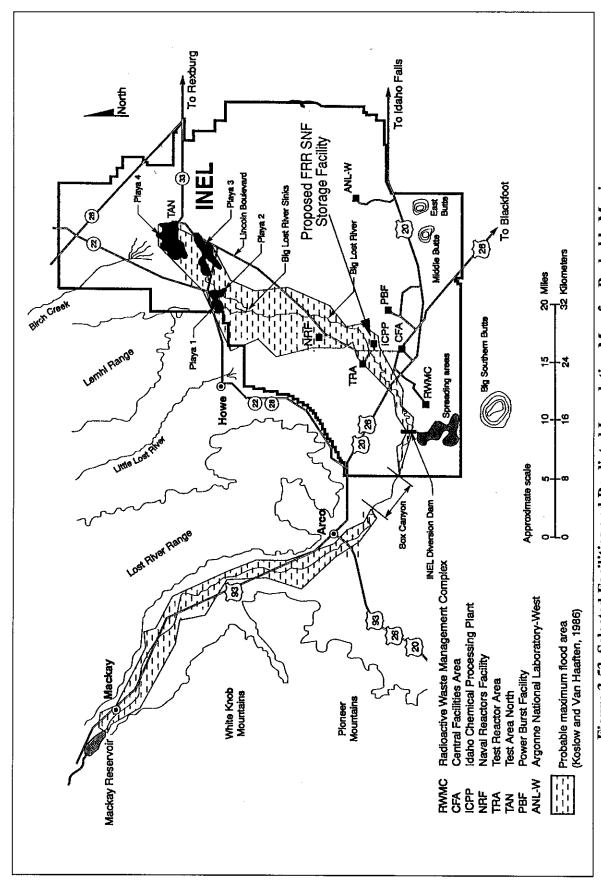
The Little Lost River drains the slopes of the Lemhi and Lost River Ranges, an area of approximately 1,826 km<sup>2</sup> (705 mi<sup>2</sup>). Surface water from the Little Lost River has not reached the Idaho National Engineering Laboratory in recent times; during high streamflow years, however, water will reach the site and infiltrate into the subsurface (EG&G Idaho Inc., 1984).

Surface water generated from local precipitation will flow into topographic depressions (lower elevations than the surrounding terrain). Surface water within the depressions either evaporates or infiltrates into the ground. Localized flooding can occur at the Idaho National Engineering Laboratory when the ground is frozen and melting snow is combined with heavy spring rains. Other facility areas have been threatened by flooding because of ice jams in the Big Lost River and its diversion channel (McKinney, 1985).

Intermittent surface flow and the Idaho National Engineering Laboratory Diversion Dam have effectively prevented the Big Lost River from flooding onto the site. Flood plains in existence before the diversion dam and channels were built are not active. Based on historical data from past storm events, if heavy runoff occurs and surface water flow from the Big Lost River is diverted to the four spreading areas, water will not overflow the banks of the existing Big Lost River channel onsite during 100- and 500-yr floods (floods that occur on an average of every 100 or 500 years).

Onsite flooding from the Big Lost River may occur if high water in the MacKay Dam or the Big Lost River is coupled with a dam failure. Assuming the Mackay Dam fails, significantly higher flows and greater flooding would be associated with the probable maximum flood than either the 100- or 500-year floods (Figure 3-53).

Surface Water Quality: Water quality in the Big Lost River, Little Lost River, and Birch Creek is similar, and has not varied significantly over the period of record. The chemical composition of these water bodies is determined primarily by the mineral composition of the rocks in surrounding mountain ranges northwest of the site, and by the chemical composition of irrigation water in contact with the surface water



Flood-Induced Overtopping Failure of Mackay Dam at the Idaho National Engineering Figure 3-53 Selected Facilities and Predicted Inundation Map for Probable Maximum Laboratory

(Robertson et al., 1974; Bennett, 1990). Chemical and physical parameters measured in the Big Lost River, Little Lost River, and Birch Creek do not exceed drinking water quality standards for the parameter analyzed (DOE, 1995c).

The Idaho National Engineering Laboratory activities do not directly affect the quality of surface water outside the site, because discharges from the Idaho National Engineering Laboratory facilities are made to man-made seepage and evaporation basins or stormwater injection wells. Surface water is not withdrawn by humans for use at the Idaho National Engineering Laboratory, and discharge of effluents to natural surface waters does not occur. In addition, surface water does not flow directly offsite (Hoff et al., 1990). However, water from the Big Lost River, as well as from seepage of evaporation basins and stormwater injection wells, does infiltrate into the Snake River Plain Aquifer, and will eventually reach the Snake River (Robertson et al., 1974; Wood and Law, 1988; Bennett, 1990).

#### 3.3.2.3.2 Groundwater

Groundwater at the site occurs in the Snake River Plain Aquifer and the vadose zone. The Idaho National Engineering Laboratory overlies the Snake River Plain Aquifer, which covers an area of approximately 24,900 km<sup>2</sup> (9,614 mi<sup>2</sup>). Groundwater in the aquifer generally flows south and southwestward across the Snake River Plain, discharging into the Snake River at the Thousand Springs Area near Twin Falls, ID.

The Snake River Plain Aquifer is recharged by seepage of irrigation water, stream channel and canal leakage, tributary drainage basin underflow, and direct infiltration from precipitation (Garabedian, 1989). The drainage basin recharging the aquifer covers an area of approximately 90,643 km<sup>2</sup> (35,000 mi<sup>2</sup>). Most recharge occurs in surface water-irrigated areas and along the northeastern margins of the plain. A majority of the groundwater discharged from the aquifer is through springs that flow into the Snake River, and through pumping for irrigation purposes. Major springs and seepages that flow from the aquifer are located near the American Falls Reservoir (southwest of Pocatello) and the Thousand Springs area between Milner Dam and King Hill (near Twin Falls, ID).

Water storage in the Snake River Plain Aquifer is estimated at 2.5 x  $10^{+12}$  m<sup>3</sup> (8.8 x  $10^{+13}$  ft<sup>3</sup>) (Robertson et al., 1974). Irrigation wells yield as much as 26.5 m<sup>3</sup> per min (7,000 gal per min) of water (Garabedian, 1989). Groundwater discharges primarily from the aquifer through springs that flow into the Snake River and from pumping for irrigation purposes. Major springs and seepages that flow from the aquifer are localized near the American Falls Reservoir (southwest of Pocatello) and the Thousand Springs area between Milner Dam and King Hill.

The Idaho National Engineering Laboratory covers 2,305 km² (890 mi²) of the north-central portion of the Snake River Plain Aquifer. Most of the aquifer is composed of a thick sequence of relatively thin basaltic lava flows with sedimentary interbeds extending to depths greater than 1,067 m (3,500 ft) below the land surface (Irving, 1993). The basalt flows are interbedded with sedimentary layers formed during periods between volcanic eruptions when the basalt was exposed and sediments collected on the land surface. A majority of the groundwater moves horizontally through fractured, basaltic interflow zones (broken and rubble zones) that occur at various depths. Water also moves vertically along joints and the interfingering edges of interflow zones (Garabedian, 1986). Sedimentary interbeds restrict the vertical movement of groundwater.

Depths to the water table from the land surface at the Idaho National Engineering Laboratory range from approximately 61 m (200 ft) in the north, to more than 274 m (900 ft) in the south (Pittman et al., 1988). The upper surface of the aquifer is unconfined over most of its extent. However, the aquifer generally behaves as if it were partially confined, because water moves through dense basalt with interbedded

sediments and water-bearing basaltic fracture zones at different rates. The base of the aquifer coincides with the tip of a thick, widespread sequence of clay, silt, sand, and basalt that occurs at depths ranging from 244 to 457 m (800 to 1,500 ft) below the land surface. The thickness of the aquifer is primarily controlled by the geologic setting, and therefore varies across the Idaho National Engineering Laboratory (Anderson, 1991).

The rate water moves through the aquifer depends on the gradient (change in elevation with distance) of the water table, the porosity of the soil and bedrock (void spaces in aquifer materials), and the hydraulic conductivity of the soil and bedrock (capacity of a porous media to transport water). Across the Idaho National Engineering Laboratory, the horizontal gradient of the water table ranges from 0.19 to 2.9 m/km (1 to 15 ft/mi) (Ackerman, 1991). Vertical hydraulic gradients (change in elevation, pressure, and velocity with distance in a given direction) are usually less than 0.01 m/m (0.01 ft/ft) in the first 61 m (200 ft) below the land surface, and less than 0.02 m/m (0.02 ft/ft) in the first 168 m (550 ft) of the saturated thickness. Groundwater flows horizontally at velocities ranging from 1.5 to 7.6 m/day (5 to 25 ft/day). However, most of the water flows from 1.5 to 3 m/day (5 to 10 ft/day) (Robertson et al., 1974).

Transmissivity values vary widely across the Idaho National Engineering Laboratory. Data from 183 single-well tests at 94 wells provide estimates of transmissivity ranging from 0.1 to 70,604 m<sup>2</sup> per day (1.1 to 760,000 ft<sup>2</sup> per day) (Ackerman, 1991). The lowest transmissivity rates are generally at the northern end of the Idaho National Engineering Laboratory, and the highest rates are near the Test Reactor Area in the south-central part of the Idaho National Engineering Laboratory. Aquifer storativity is estimated using results from multiple-well aquifer tests. Values of storativity (or storage coefficients) range from 0.01 to 0.06, indicating generally unconfined aquifer conditions at the site. The aquifer behaves as an unconfined system, which increases well yields. However, clay layers and dense, unfractured basalts in the aquifer are locally confining.

Since aquifer porosity and hydraulic conductivity decrease with depth, most of the water in the aquifer moves through the upper 61 to 152 m (200 to 500 ft) of the Quaternary basalts. Estimated flow rates within the aquifer range from 1.5 to 6.1 m (5 to 20 ft) per day. Recharge to the aquifer near the Idaho National Engineering Laboratory originates from precipitation in the mountains to the north and west. Lesser amounts of recharge occur from local precipitation and snowmelt (Barraclough et al., 1981).

The vadose zone at the Idaho National Engineering Laboratory extends from the land surface down to the water table, with a thickness ranging from 61 m (200 ft) in the north, to greater than 274 m (900 ft) in the south. The vadose zone consists of surface sediments and relatively thin, basaltic lava flows with occasional interbedded sediments. The surface sediments are composed of clay, silt, sand, and gravel. Thick surficial deposits of (primarily) clay and silt are found in the northern portion of the Idaho National Engineering Laboratory, and thin deposits are found southward, where basalt is exposed at the surface.

Perched water at the site generally occurs under presence of disposal ponds or other surface water features. Perched water bodies have been detected at the Idaho Chemical Processing Plant, Test Reactor Area, Test Area North, and Radioactive Waste Management Complex facility areas.

Groundwater Quality: Previous waste discharges to unlined ponds and deep wells have introduced radionuclides, nonradioactive metals, inorganic salts, and organic compounds to the subsurface (DOE, 1995c).

Radionuclide concentrations in the Snake River Plain Aquifer beneath the Idaho National Engineering Laboratory have decreased since the mid-1980's because of changes in disposal practices, radioactive decay, adhesion of radionuclides to rocks and minerals, and dilution by natural surface water and

groundwater entering the aquifer (Pittman et al., 1988; Orr and Cecil, 1991). Radionuclides released and observed in the soil and groundwater include tritium, strontium-90, iodine-129, cobalt-60, cesium-137, plutonium-238, plutonium-239/240, and americium-241 (Golder Associates, 1993).

The Idaho National Engineering Laboratory has released sodium, chromium, lead, and mercury on the site and into the subsurface through unlined ponds and deep wells. Sodium is the greatest quantity of material released from the waste treatment processes. However, sodium is not toxic. In 1988, chromium concentrations exceeding the maximum allowable contaminant level were measured near the Test Reactor Area. Lead and mercury have occurred at concentrations below the maximum contaminant level near the Idaho Chemical Processing Plant (Orr and Cecil, 1991).

Concentrations of volatile organic compounds have been detected in the aquifer beneath the Idaho National Engineering Laboratory. Concentrations of the following compounds exceeding the maximum contaminant levels have occurred in and near the Test Area North disposal well: Carbon tetrachloride; chloroform; 1,2-cis-dichloroethylene; 1,1-dichloroethylene; 1,2-trans-dichloroethylene; trichloroethylene; tetrachloroethylene; and vinyl chloride (Leenheer and Bagby, 1982; Mann and Knobel, 1987; Liszewski and Mann, 1993).

Groundwater uses on the Snake River Plain include irrigation, food processing and agriculture, and domestic, rural, public, and livestock supply. Water use for the upper Snake River drainage basin and Snake River Plain Aquifer was  $16.4 \times 10^{+10}$  cubic m  $(4.3 \times 10^{+12} \text{ gal})$  per year during 1985, which was more than 50 percent of the water used in Idaho, and approximately 7 percent of agricultural withdrawals in the nation. Site activities withdraw water at an average rate of  $7,400,000 \text{ m}^3$  ( $1.9 \times 10^{+9} \text{ gal}$ ) per year. This rate is equal to approximately 0.4 percent of the water consumed in the Eastern Snake River Plain Aquifer (DOE, 1995c).

Since groundwater supplies 100 percent of the drinking water consumed within the Eastern Snake River Plain (Gaia Northwest, 1988), and an alternative drinking water source or combination of sources is not available, the U.S. Environmental Protection Agency designated the Snake River Plain Aquifer a sole-source aquifer in 1991 (EPA, 1991b).

The Idaho Department of Water Resources manages groundwater resources to meet the State's water needs. Idaho operates under the system of appropriation rights — the senior appropriation has priority in times of shortage, or "first in time, first in right."

DOE holds a Federal Reserved Water Right for the Idaho National Engineering Laboratory, which permits a water pumping capacity of 2.3 m<sup>3</sup> per sec (80 ft<sup>3</sup> per sec), and a maximum water consumption of 43 million m<sup>3</sup> per year (11.4 billion gal per year) for drinking, process water, and noncontact cooling. Because it is a Federal Reserved Water Right, the Idaho National Engineering Laboratory's priority on water rights dates back to the establishment of the Idaho National Engineering Laboratory.

## 3.3.2.4 Meteorology

The Eastern Snake River Plain climate exhibits low relative humidity, wide daily temperature swings, and large variations in annual precipitation. Several topographic characteristics of the area (including altitude, latitude, and intermountain setting) influence the climate of the site area.

Wind: The terrain impacts the regional wind flow. The Idaho National Engineering Laboratory is in the belt of prevailing westerlies. Nighttime winds are common at the Idaho National Engineering Laboratory on clear or partly cloudy nights. These winds blow from the northeast and are formed by the rapid

rotational cooling of the near-ground air layer on mountain slopes. Wind directions with the highest frequency of occurrence as measured onsite, are from south to west-southwest and from northwest to northeast (Clawson et al., 1989).

The highest hourly average near-ground (6.1 m, 20 ft level) windspeed measured onsite is 22.8 m per sec (51 mph) from the west-southwest. The maximum instantaneous gust at this level was 34.9 m per sec (78 mph). Some of the highest windspeeds occur in the spring, which coincides with strong prevailing westerlies at higher altitudes (Clawson et al., 1989). Apart from thunderstorms, severe weather is uncommon. Visibility in the region is good due to the low moisture content of the air and minimal sources of visibility-reducing pollutants. The background visibility is estimated at 60 km (37.5 mi).

Temperature and Humidity: Average seasonal temperatures measured onsite range from -7.3°C (18.8°F) in winter to 18.2°C (64.8°F) in summer, with an annual average temperature of about 5.6°C (42°F). Temperature extremes measured at the Idaho National Engineering Laboratory range from a summertime maximum of 39.4°C (103°F), to a wintertime minimum of -45°C (-49°F). Temperature differences in excess of 13.9°C (25°F) have been observed onsite (Clawson et al., 1989).

The annual average relative humidity at the Idaho National Engineering Laboratory is 50 percent, with monthly average maximum values ranging from 59 percent in July to 89 percent in February and December, and with monthly average minimum values ranging from 16 percent in June and July to 47 percent in January (Clawson et al., 1989).

Precipitation: Annual precipitation is light, averaging 22.12 cm (8.71 in). The monthly average precipitation peaks in May and June. For the rest of the year, precipitation is uniformly distributed, averaging 1.27 to 1.78 cm (0.5 to 0.7 in) monthly. The highest monthly average snowfall of 16.26 cm (6.4 in) occurs in December, with similar amounts during January. The average annual snowfall is 70.1 cm (27.6 in). Maximum annual snowfall is 151.6 cm (59.7 in), and minimum annual snowfall is 17.3 cm (6.8 in) (Clawson et al., 1989).

Atmospheric Dispersion: Vertical diffusion of pollutants may be restricted or enhanced by the vertical temperature gradient of the atmosphere (that is, lapse or inversion conditions). These inversions are often ground-based, meaning that the temperature increases with height from the ground (Clawson et al., 1989).

Air Quality: The population of the Eastern Snake River Plain is exposed to environmental radiation from both natural and man-made sources.

Background radiation includes sources such as cosmic rays, radioactivity naturally present in soil, rocks, and the human body, and airborne radionuclides of natural origin (such as radon). Radioactivity still remaining in the environment as a result of atmospheric testing of nuclear weapons also contributes to the background radiation level, although in very small amounts.

The Programmatic SNF&INEL Final EIS presents a summary of the estimated natural background dose by exposure source for residents of the Eastern Snake River Plain (DOE, 1995c). The cumulative annual dose, 351 mrem, is caused largely by the inhalation of radioactive particles formed by the decay of naturally occurring radon.

Sources of radiological emissions at the Idaho National Engineering Laboratory result from operation of research and training reactors, spent nuclear fuel testing and processing, irradiated material and fuel examination, nuclear waste treatment and storage, and depleted uranium armor production. These operations can result in the release of radioactivity to air, either directly (e.g., through stacks or vents) or indirectly (e.g., by re-suspension of radioactivity on contaminated grounds). Concentrations of

radionuclides in direct releases are monitored or estimated based on knowledge of the materials used and activities performed. Indirect releases are estimated using engineering calculations that relate surface contamination levels to expected airborne concentrations.

Table 4.7-2 of Appendix B, Volume 1 of the Programmatic SNF&INEL Final EIS provides a summary of the principal types of airborne radioactivity emitted from the Idaho National Engineering Laboratory operations during 1991 (DOE, 1995c). The information summarized provides a perspective on the general nature and magnitude of airborne radiological emissions from current the Idaho National Engineering Laboratory operations. These emissions include the noble gases (argon, krypton, and xenon) and iodine; particulate fission products such as rubidium, strontium, and cesium; radionuclides formed by neutron activation such as tritium (hydrogen-3), carbon-14, and cobalt-60; and very small quantities of heavy elements such as uranium, thorium, plutonium, and their decay products. The emissions listed are considered representative of a maximum baseline year. The radionuclide with the highest emission rate is the noble gas, krypton-85. Most of the krypton-85 emissions result from the chemical reprocessing of spent nuclear fuel at the Idaho Chemical Processing Plant.

### 3.3.2.5 **Ecology**

The Idaho National Engineering Laboratory vegetation consists primarily of shrub-steppe vegetation, and is a small fraction of the 45 million ha (112.5 million acres) of this vegetation type found in the Intermountain West. Vegetation communities range from shadscale-steppe vegetation at lower altitudes, through sagebrush and grass-dominated communities, to juniper woodlands along the foothills of the nearby mountains and buttes. Big sagebrush and rabbitbrush are the most common and noticeable shrub species on the Idaho National Engineering Laboratory. Other common shrubs include winterfat, perennial broomweed, black sage, and saltbrush species. Grass species common to the Idaho National Engineering Laboratory include Indian ricegrass, Great Basin wildrye, needle-and-threadgrass, wheatgrasses, bottlebrush squirreltail, and cheatgrass. Common flora species include mustards, summer cypress, and Russian thistle. Fifteen vegetation classes have been identified at the Idaho National Engineering Laboratory. The classes can be grouped into six major types: juniper woodland, native grassland, shrub-steppe, lava, modified, and wetland vegetation types.

The Idaho National Engineering Laboratory supports animal communities typical of Great Basin high desert vegetation and habitats. About 270 vertebrate species have been observed, including 46 mammal, 204 bird, 10 reptile, 2 amphibian, and 9 fish species (Arthur et al., 1984; DOE, 1995c). Thirty-seven mammal species or their signs have been observed at the site. Included are 14 rodents, 4 lagomorphs (rabbits and hares), 6 bats, 6 carnivores, 4 ungulates (hoofed animals), and 1 shrew. A total of 185 bird species were recorded on the site (DOE, 1995c). Other species may be present on the Idaho National Engineering Laboratory since more than 216 bird species have been reported in southeastern Idaho in similar habitats. Of these species, 32 are game birds, 26 are waterfowl, 82 are passerines, and 22 are raptors (for example, hawks, eagles, and owls). Waterfowl use man-made ponds and lagoons at the Idaho National Engineering Laboratory, and the Idaho National Engineering Laboratory is a nesting and wintering area for raptors. Sage grouse and their habitat are found throughout the site. Ten reptile and one amphibian species have been observed on the Idaho National Engineering Laboratory, but only five are common or abundant (DOE, 1995c). These species include western rattlesnake, short-horned lizard, sagebrush lizard, Great Basin spadefoot toad, and western garter snake.

Two Federal endangered and six Federal Category 2 Candidate animal species were identified by the U.S. Fish and Wildlife Service as potentially existing on the Idaho National Engineering Laboratory (DOE, 1995c). Seven additional animal species listed by the State as species-of-special-concern were identified. No Federal-or State-listed plant species were identified as potentially existing on the Idaho National

Engineering Laboratory. The bald eagle and peregrine falcon are Federally listed endangered species. The bald eagle is a winter resident and is locally common in the far north end of the Idaho National Engineering Laboratory, and on the western edge of the site near Howe. Peregrine falcons have been rarely observed in the winter. Neither species is known to nest on the site, and neither species is commonly observed near facilities (Reynolds, 1993).

The Candidate Category 2 species identified by the U.S. Fish and Wildlife Service as potentially existing at the Idaho National Engineering Laboratory include four birds and two mammals. Both the long-billed curlew and the white-faced ibis are uncommon migrants at the Idaho National Engineering Laboratory, associated with aquatic and riparian habitats. Swainson's hawk and ferruginous hawk nest on and migrate through the site. These species are found throughout the site, but are observed more frequently in the juniper woodlands and riparian areas where they nest. The loggerhead shrike, which uses shrub-steppe vegetation to nest, is also found on the Idaho National Engineering Laboratory. Breeding and hibernation caves for Townsend's big-eared bat have been observed on the Idaho National Engineering Laboratory. About six caves are used, the nearest being in excess of 7 km (3 mi) from the nearest facility. The pygmy rabbit is common on the Idaho National Engineering Laboratory (DOE, 1995c). The habitat for this species is grass and shrub communities found throughout much of the Idaho National Engineering Laboratory.

State species-of-special-concern include three aquatic, one raptor, and three bat species. The aquatic bird species are rare migrants (DOE, 1995c). The gray falcon has only been observed a few times. Of the bats, only the California myotis has been observed, and it is rare. Ten plant species identified by other Federal agencies (U.S. Bureau of Land Management and U.S. Forest Service) and the Idaho Native Plant Society as sensitive, rare, or unique are known to occur on the Idaho National Engineering Laboratory (Chowlewa and Henderson, 1984). These species are not, however, protected under State or Federal laws. Most of these species are not found near any the Idaho National Engineering Laboratory facilities, and are uncommon on the Idaho National Engineering Laboratory because they require unique microhabitat conditions.

Potential wetlands are found throughout the Idaho National Engineering Laboratory and cover about 0.25 percent (3,322 ha or 8,206 acres) of the site. The wetlands are associated primarily with drainages, although some wetlands are associated with natural playas, man-made ponds, and drainage ditches. More than 70 percent of the potential wetlands are identified as palustrine (marsh lands). These wetlands are found mainly near the Big Lost River and its spreading areas and playas, the Birch Creek Playa, and an area to the north and in the general vicinity of Argonne National Laboratory-West. Potential lacustrine wetlands are found in the central and south central portions of the site. Potential riverine wetlands were mapped by the U.S. Fish and Wildlife Service near the Big Lost River, Birch Creek, and Big Lost River Playas. Man-made wetlands include industrial waste and sewage treatment ponds, borrow pits, and gravel pits associated with site facilities. Limited riparian communities with large trees are found along the drainages of the Big Lost River, and very limited riparian habitat is located on Birch Creek.

#### 3.3.2.6 Land Use

The Idaho National Engineering Laboratory encompasses 231,049 ha (570,934 acres). Only about two percent of the land (4,614 ha or 11,400 acres) is used for facilities and operations supporting energy research and development and waste management. In addition to industrial and support land uses associated with each of the facility areas at the Idaho National Engineering Laboratory, other land uses exist within the Idaho National Engineering Laboratory site boundaries.

Approximately five percent of the total the Idaho National Engineering Laboratory site area, or 13,349 ha (33,000 acres), is devoted to public road, utility, and railway rights-of-way crossing the site (DOE, 1995c). Rights-of-way at the Idaho National Engineering Laboratory are granted and administered by the U.S. Department of the Interior and the Bureau of Land Management.

More than half of the Idaho National Engineering Laboratory is used for grazing. The actual amount of the Idaho National Engineering Laboratory land used for grazing varies from year to year, but is usually between 121,410 and 141,645 ha (300,000 and 350,000 acres). In 1992 for example, 121,853 ha (301,094 acres) were grazed (DOE, 1995c). Grazing is not allowed within 3.2 km (2 mi) of any nuclear facility, and dairy cattle are not permitted on the site to avoid the possibility of milk contamination by long-lived radionuclides. The U.S. Sheep Experiment Station, located approximately 42.6 km (26.5 mi) northeast of the site, uses a 364 ha (900 acre) portion of the Idaho National Engineering Laboratory for a winter feed lot for approximately 5,000 sheep.

The Idaho National Engineering Laboratory also supports periodic uses associated with onsite resources. Two sites within the Idaho National Engineering Laboratory site boundary are listed in the National Register of Historic Places: Experimental Breeder Reactor-I, designated in 1966, and Goodale's Cutoff, a portion of the Oregon Trail that crosses the southwest corner of the Idaho National Engineering Laboratory, designated in 1974. In addition to public tours, the Idaho National Engineering Laboratory occasionally supports controlled hunting within the site boundaries. Each year the Idaho Department of Fish and Game and DOE jointly determine whether or not to allow controlled hunts of wild game populations living on the Idaho National Engineering Laboratory property (DOE, 1995c).

Several uses associated with the National Environmental Research Park designation occur at the Idaho National Engineering Laboratory's cool desert ecosystem provides a controlled outdoor laboratory where scientists can study changes to the natural environment caused by human activities.

#### 3.3.2.7 Noise

Sources of man-made noise at the Idaho National Engineering Laboratory include noise from operation and construction activities; bus, car, and truck traffic; aircraft; security force training exercises; and the Idaho National Engineering Laboratory railroad. Previous studies have assessed noise impacts of existing the Idaho National Engineering Laboratory operational activities (Abbott et al., 1990). These studies concluded that because of the remote location of the Idaho National Engineering Laboratory, there are no known noise conditions associated with existing onsite operations that adversely affect individuals at offsite locations. Studies of the noise effects on wildlife at the Kennedy Space Center show that even very high noise levels have little significance on wildlife productivity (Leonard, 1993).

## 3.3.2.8 Transportation

Roads are the primary access to and from the site, and workers are transported primarily by bus and private vehicles. Commercial shipments are transported by road and air, and some bulk materials are transported by rail. Waste is transported by road and rail. The existing regional highway system and site roadways are shown in Figure 3-54. To maintain a supply of goods and services and to transport workers to the Idaho National Engineering Laboratory, an onsite road system of approximately 145 km (90 mi) of paved surface has been developed. About 29 km (18 mi) of this network are considered service roads and are closed to the public. In addition to the site facilities, DOE owns or leases office and technical buildings throughout Idaho Falls for approximately 4,000 DOE and DOE contractor personnel to administer and support work at the Idaho National Engineering Laboratory. DOE shuttle vans provide

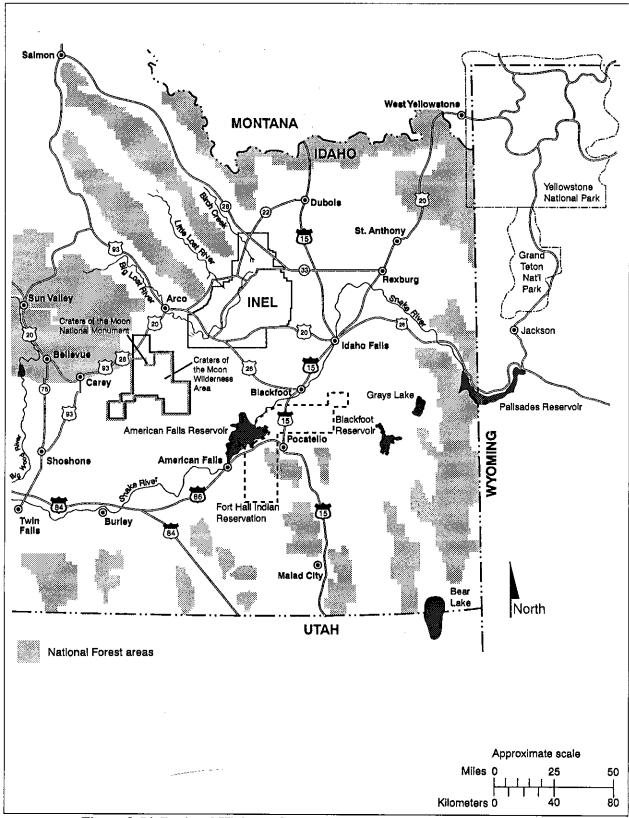


Figure 3-54 Regional Highway System and the Idaho National Engineering Laboratory Site Roadways

hourly transport between in-town facilities. Four major modes of transit use the regional highways, community streets, and site roads to transport people and commodities: DOE buses and shuttle vans, DOE motor pool vehicles, commercial trucks, and private automobiles.

Idaho Falls receives railroad freight service from Butte, Montana to the north, and from Pocatello, and Salt Lake City, Utah to the south via Union Pacific. The Union Pacific Railroad's Mackay Branch, which crosses the southern portion of the Idaho National Engineering Laboratory, provides rail service to the Idaho National Engineering Laboratory. This branch connects with a DOE-owned spur line at Scoville Siding, and then links with developed areas within the Idaho National Engineering Laboratory. Rail shipments to and from the Idaho National Engineering Laboratory are usually limited to bulk commodities, spent nuclear fuel, and radioactive materials.

One major airline carrier, Delta Airlines, provides Idaho Falls with jet aircraft passenger and cargo service. Two other air carriers, Horizon and Skywest, provide commuter service. Daily service includes flights to and from Boise and Salt Lake City. Landings in Idaho Falls for 1991 and 1992 totalled 5,367 and 5,578, respectively. The combined number of passengers leaving and arriving at Idaho Falls and Pocatello for 1991 and 1992 was 282,185 and 285,047, respectively. Non-DOE air traffic over the Idaho National Engineering Laboratory is restricted, and non-DOE aircraft are not permitted to use the site.

From 1987 through 1992, the average motor vehicle accident rate was 0.94 accident per million km (1.5 accidents per million mi) for Idaho National Engineering Laboratory vehicles, which compares with an accident rate of 1.5 accidents per million km (2.4 accidents per million mi) for all DOE complex vehicles and 8 accidents per million km (12.8 accidents per million mi) nationwide for all motor vehicles. There are no recorded rail or air accidents associated with the Idaho National Engineering Laboratory and, to date, no fatal air traffic accidents have involved flights through either the Idaho Falls or Pocatello airports (DOE, 1995c). Spent nuclear fuel and radioactive, hazardous, industrial, municipal, and recyclable wastes are transported at the Idaho National Engineering Laboratory.

#### 3.3.2.9 Socioeconomics

In general, population growth in the region has mirrored population growth in Idaho as a whole over the past 30 years (Figure 3-55). Although growth was not evenly distributed among the counties, total regional population increased by 47 percent between the years 1960 to 1990, which is comparable to a Statewide growth rate of 51 percent. During this period, Madison County experienced the most rapid growth in the region, its population increasing by more than 150 percent. By contrast, the two smallest counties in the region, Butte and Clark, actually lost population between the years 1960 and 1990. The largest increases in the population of Idaho Falls occurred during the 1950's, which can be partially explained by the formation and the development of the National Reactor Testing Station, which evolved into the Idaho National Engineering Laboratory. By contrast, Pocatello grew primarily in the 1940's and the 1960's. Idaho Falls has continued to grow, increasing in population by 11 percent from the years 1980 to 1990. During the same period, however, Pocatello's population declined by 0.7 percent.

Historically, the economy of the seven-county region relied predominantly on natural resource use and extraction. To this day, farming, ranching, and mining remain important components of the regional economy. Almost all manufacturing in the region is a form of food processing, and mining or mineral processing. Idaho Falls is a regional retail and service center for southeastern Idaho. Similarly, Pocatello has evolved into an important processing and distribution center for the surrounding agricultural areas, and is a regional center for higher education. Retail trade and educational services are the two largest regional employment categories, providing 17.6 and 11.4 percent of the total employment in the region. Tourism is also considered to be an important component of the regional economy. The economy of the seven-county

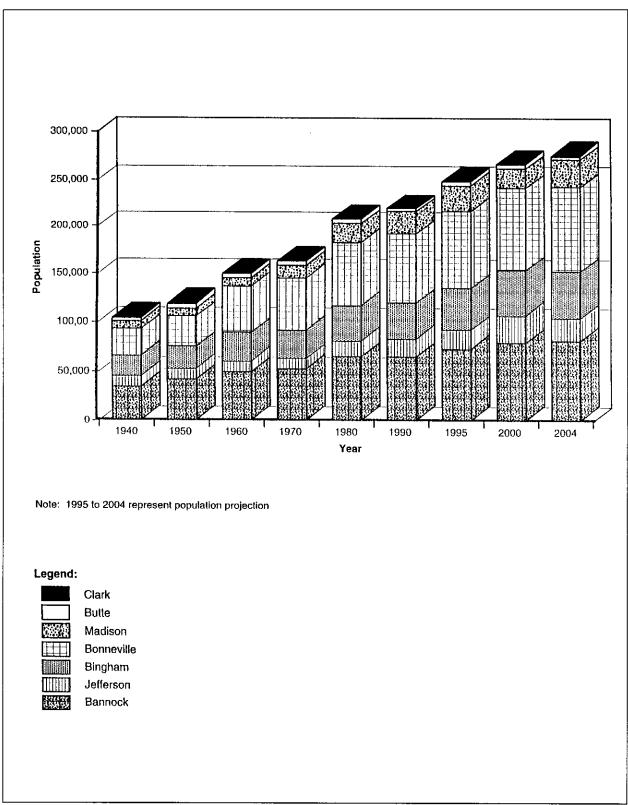


Figure 3-55 Actual and Projected Total Population for the Seven-County Region Surrounding the Idaho National Engineering Laboratory for the Years 1940 through 2004

region, however, currently revolves around agriculture and the Idaho National Engineering Laboratory (the single largest employer in the seven-county region). As of January 1991, DOE and its contractors employed more than 12,425 persons, with an estimated annual payroll of \$440 million. Annual funding for the Idaho National Engineering Laboratory in 1991 was more than \$1.1 billion.

As of January 1992, 12,803 contractor and Government personnel were employed at the Idaho National Engineering Laboratory, representing about 12 percent of the total available jobs in the seven-county region. Total employment at the Idaho National Engineering Laboratory has increased by more than 23 percent in the past 4 years. The Idaho National Engineering Laboratory has a large influence on both the regional economy and the economy of Idaho. During Fiscal Year 1992, total expenditures at the Idaho National Engineering Laboratory directly and indirectly supported 36,395 jobs, and generated an estimated \$945 million in total earnings within the seven-county region.

Bonneville and Bannock Counties are the focal points of the housing market. These two counties provide 67 percent of the total housing in the region. A shortage of single-family housing presently exists near Idaho Falls because construction has not kept up with increasing demand. Total population living within the 80 km (50 mi) radius around the site is about 176,311. The ethnic composition of this population is presented in Figure 3-56. The number of low-income households within the same area of influence is presented in Figure 3-57. Approximately 40 percent of these households are low income families.

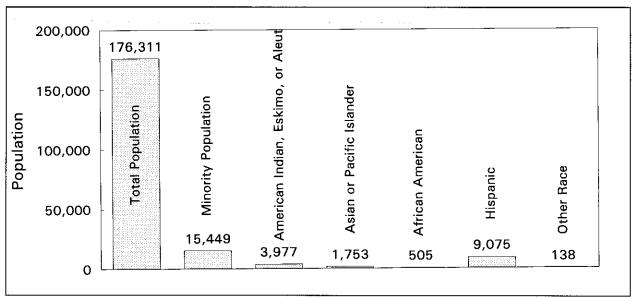


Figure 3-56 Racial and Ethnic Composition of the Minority Population Residing within 80 km (50 mi) of the Idaho National Engineering Laboratory

Seventeen public school districts provide educational services for 56,899 school-aged children within the seven-county region. Most of the public schools in the seven-county region operate at levels at or above the design capacity of their classroom facilities.

There are 18 fire districts in the seven-county area surrounding the Idaho National Engineering Laboratory. These 18 districts operate a total of 30 fire stations staffed by 179 paid and 313 volunteer firefighters. Bingham, Bonneville, Butte, Clark, and Jefferson counties, which surround the Idaho National Engineering Laboratory, have developed emergency plans to be implemented in the event of a radiological or hazardous materials emergency. Eight hospitals serve the seven-county region. The Eastern Idaho Regional Medical Center in Idaho Falls, with 311 beds, is the largest hospital in the region. Occupancy rates range from 22.0 to 89.2 percent in the region. Law enforcement services in the

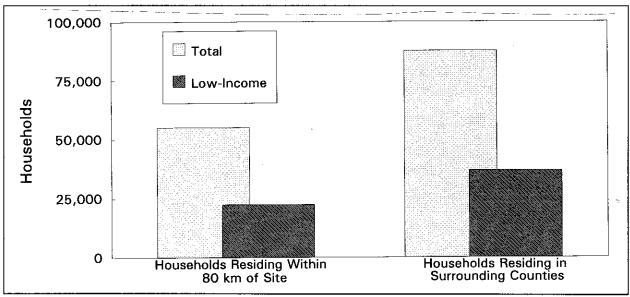


Figure 3-57 Low-Income Households Residing within 80 km (50 mi) of the Idaho National Engineering Laboratory

seven-county area are provided by sheriff's offices in each county, 12 city police departments, and the Idaho State Police. Clark County has the highest ratio of law enforcement personnel per 1,000 people (6.3 per 1,000), and Butte County has the lowest ratio (1.3 per 1,000).

### 3.3.2.10 Historical, Archaeological, and Cultural Resources

In the course of more than 100 cultural resource surveys, 1,506 cultural resources have been discovered and recorded within the Idaho National Engineering Laboratory boundaries (DOE, 1995c), not including architectural properties directly associated with the creation and operation of the Idaho National Engineering Laboratory. Only four percent of the Idaho National Engineering Laboratory has been surveyed, however, and most surveys were conducted near major facility areas. The 1,506 resources recorded at the Idaho National Engineering Laboratory through 1992 include 688 prehistoric sites, 38 historic sites, 753 prehistoric isolated finds, and 27 historic isolated finds (DOE, 1995c; Gilbert and Ringe, 1993). Until formal evaluations can be performed, all of the cultural sites are considered to be potentially eligible for the National Register of Historic Places. Only Goodale's Cutoff, part of the Northern Alternate of the Oregon Trail, is listed on the National Register of Historic Places. All of the isolated find artifacts have been categorized as unlikely to meet eligibility requirements (Yohe, 1993).

Most of the 688 prehistoric archaeological sites located to date at the Idaho National Engineering Laboratory are classified as lithic scatters. These sites consist of more than 10 stone artifacts, but lack evidence of other categories of cultural materials or features. At 12 percent of these sites, limited subsurface excavations have been conducted. Prehistoric cultural resources vary in density and type across the Idaho National Engineering Laboratory, but appear to be associated with definable physical features of the land. Areas classified as having very high sensitivity have been identified along the Big Lost River, atop buttes, and within craters and caves. The southernmost part of the Lemhi Mountains, the Lake Terreton basin, and a 2,800 m (9,200 ft) wide zone along the edge of lava fields are classified as high-sensitivity areas. With the exception of the Central Facilities Area and Experimental Breeder Reactor-I, which are located in high-sensitivity zones, all developed Idaho National Engineering Laboratory facility areas are located in or on the edge of low or medium sensitivity areas.

As of March, 1993, 38 historic sites and 27 historic isolated finds had been recorded on the Idaho National Engineering Laboratory (Gilbert and Ringe, 1993). These resources include small homesteads and irrigation canals, temporary campsites of sheep and cattle drivers, stage and wagon roads, and some mining-related features.

In most instances, a property must be at least 50 years old to be considered for inclusion in the National Register of Historic Places, unless it meets certain criteria. The unique nature of existing DOE site facilities at the Idaho National Engineering Laboratory and their historic role in nuclear research and development make them eligible for special consideration regardless of their age. Two buildings dating from 1942 appear on a partial inventory of potentially significant historic the Idaho National Engineering Laboratory facilities (Braun et al., 1993). The Experimental Breeder Reactor-I is listed in the National Register of Historic Places, and is designated as a National Historic Landmark. Although the Experimental Breeder Reactor-I is the only nuclear property less than 50 years old that has been formally listed in the National Register, other DOE facilities eligible for listing have been identified, including the Auxiliary Reactor Areas I, II, III; Boiling Water Reactor Experiment V; Materials Test Reactor; Engineering Test Reactor; and the Test Area North hangar (Braun et al., 1993). The Idaho State Historic Preservation Office believes that most major structures related to nuclear research at the Idaho National Engineering Laboratory are probably eligible for the National Register (Yohe, 1993).

As of July 1993, several specific types of locations have been identified as associated with traditional religious practices. The most significant of these locations are the East and Middle Buttes located in the southern section of the Idaho National Engineering Laboratory, and more than 20 lava tube and blister cave sites, which are considered sacred by the Shoshone-Bannock Tribes. The Tribes also consider archaeological sites to be sensitive resources, especially rock art sites. The entire the Idaho National Engineering Laboratory falls within the traditional territory of the Shoshone-Bannock Tribes. These areas of concern are likely to be located within very high sensitivity zones identified for presence of prehistoric archaeological resources, such as the Big Lost River, Birch Creek, buttes, craters, caves, lava edge zones, Lemhi Mountains, and the Lake Terreton basin

### 3.3.3 Description of the Affected Environment at the Hanford Site

This section describes the potentially affected environment of the Hanford Site. The location of the Hanford Site is shown in Figure 3-58.

# **3.3.3.1** Geology

The region of the Pacific Northwest that contains the Hanford Site lies within the Columbia Intermontane physiographic province, which is bordered on the north and east by the Rocky Mountains, and on the west by the Cascade Range (Figure 3-58). The province has been a topographic and structural depression since the early Miocene period, and is subdivided into smaller physiographic units. The dominant geologic characteristics of this province are the thick accumulations of basaltic lava flows extending laterally from central Washington eastward into Idaho, and southward into Oregon (Tallman et al., 1979). The ancient basalt surface has been subsequently modified by tectonism, volcanism, weathering, and erosion.

The Columbia Intermontane Province is divided into four subprovinces. The Hanford Site is contained within the Columbia Basin subprovince, which contains most of the Columbia River Basalt Group. The Columbia Basin subprovince is further divided into six physiographic sections, with the Hanford Site located in parts of the Yakima Folds and the Central Plains sections. Much of the Columbia Basin subprovince was affected by preglacial cataclysmic flooding associated with the sudden release of water from glacial Lake Missoula. Cataclysmic floods were responsible for much of the present morphology of

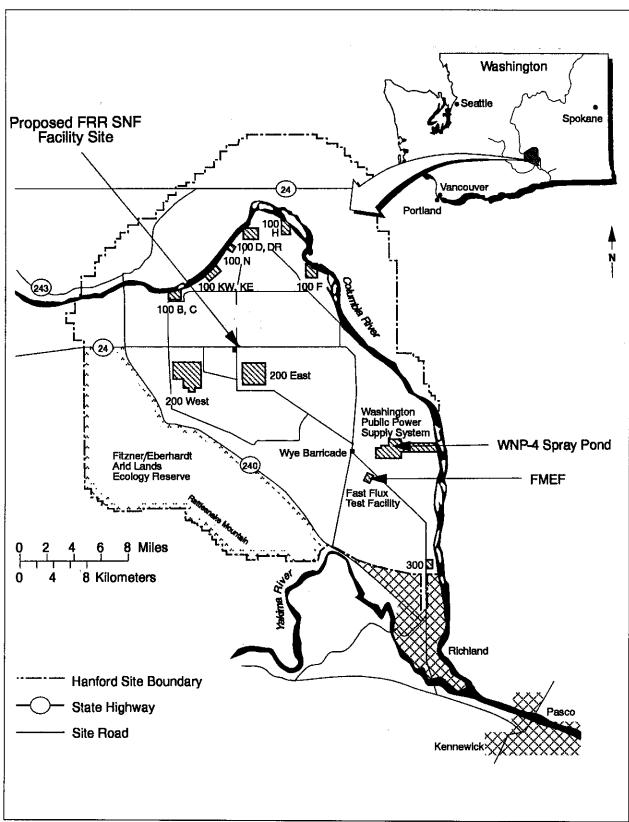


Figure 3-58 Location of the Hanford Site

the Channeled Scabland and Central Plains section. Fluvial and lacustrine processes associated with the ancestral Columbia River system have been active since the late Miocene. Sedimentary deposits indicate that deposition was continuous from about 10.5 million years ago until about 3.5 million years ago (DOE, 1988c). Quaternary volcanism has been limited to the extreme western margin of the Columbia Basin subprovince, and is associated with the Cascade Range Province.

The Hanford Site is located within the Pasco Basin, which was formed by the deformation of the lava flows into broad structural and topographic basins. The Pasco Basin is defined by anticlinal structures of basaltic rock known as the Saddle Mountains to the north, the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills to the west, and a series of doubly plunging anticlines merging with the Horse Heaven Hills to the south.

Most known faults within the region are associated with anticlinal fold axes, and were probably formed concurrently with the folding (DOE, 1986a). Existing known faults within the Hanford Site area include tear faults with lengths of up to 3 km (1.9 mi) on Gable Mountain, and the Rattlesnake-Wallula alignment. Strike-slip faults have not been observed crosscutting the Pasco Basin. Structures within the Hanford Site have shown the greatest deformation along the hinge area of the anticlinal ridges, decreasing with distance from that area (i.e., the greatest amount of tectonic jointing and faulting occurs in the hinge zone and decreases toward the gently dipping limbs). The faults usually exhibit low dips with small displacements, may be confined to the layer in which they occur, and die out to no recognizable displacement in short lateral distances (DOE, 1986a).

Fifteen different soil types present on the Hanford Site have been listed and described (Hajek, 1966). The soil types vary from sand to silty and sandy loam.

## 3.3.3.2 Seismology and Volcanology

Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is relatively low compared to other regions of the Pacific Northwest, the Puget Sound area, and western Montana/eastern Idaho. Figure 3-59 shows the locations of all earthquakes that occurred in the Columbia Plateau from 1850 to 1969 with Modified Mercalli Intensity of 5 or greater. Swarms of small, shallow earthquakes lasting from several weeks to months, and clustered in an area 5 to 10 km (3 to 6 mi) in lateral dimension are the predominant seismic events. Earthquake swarms may contain from four to more than 100 earthquakes of magnitude 1.0 to 3.5. Detailed locations of swarm earthquakes indicate that the events occur on fault planes of variable orientation and not on a single hroughgoing fault plane (DOE, 1995c).

Shallow earthquake swarm activity in the central Columbia Plateau is concentrated principally north and east of the Hanford Site. Here, earthquakes of magnitude greater than 3.0 occur, with the largest recorded (in 1973) having magnitude 4.4 north of the Hanford Site. Deeper earthquakes occur in the central Columbia Plateau, although at much lower frequencies than the shallower swarm events. Deep seismic activity generally occurs randomly, and is not associated with known geologic structures or with patterns of shallow seismicity. Earthquake focal mechanisms in the central Columbia Plateau generally indicate reverse faulting on east-west planes, consistent with a north-south directed maximum compressive stress, and with the formation of the east-west oriented anticlinal fold of the Yakima Fold Belt (Rohay, 1987). The earthquake focal mechanisms in the western margin of the Columbia Plateau also indicate north-south compression, but here the minimum compressive stress is oriented east-west, resulting in strike-slip faulting (Rohay, 1987).

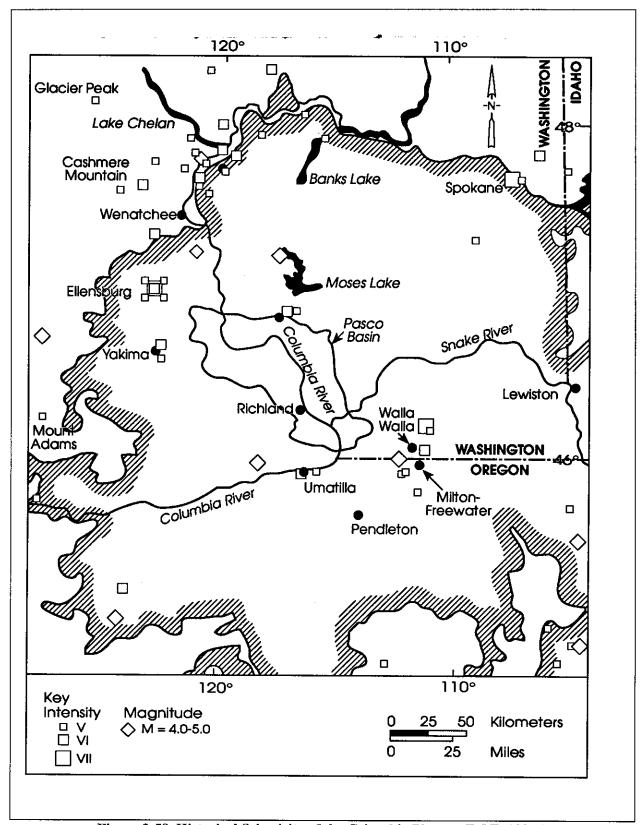


Figure 3-59 Historical Seismicity of the Columbia Plateau (DOE, 1995c)

There are several major volcanoes in the Cascade Range west of the Hanford Site. The nearest volcano is Mount Adams, about 165 km (103 mi) from the Hanford Site, and the most active is Mount St. Helens, approximately 220 km (137 mi) west-southwest from the Hanford Site.

#### 3.3.3.3 Hydrology

The major geologic units of the Hanford Site are, in ascending order: basement rocks of unknown origin and composition, the Columbia River Basalt Group with interbedded sediments of the Ellensburg Formation, the Ringold Formation, the Plio-Pleistocene unit, and the Hanford formation.

#### 3.3.3.3.1 Surface Water

The Hanford Site occupies approximately 33 percent of the land area within the Pasco Basin. Primary surface-water features associated with the Hanford Site are the Columbia and Yakima Rivers. Several surface ponds and ditches are present, and are generally associated with fuel and waste processing activities (Figure 3-60). There is no significant surface water flow from the Hanford Site to nearby rivers.

Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage system along the southern boundary of the Hanford Site. Rattlesnake Springs, located on the western part of the Hanford Site, forms a small surface stream that flows for about 3 km (1.9 mi) before disappearing into the ground.

Normal river elevations within the Hanford Site range from 120 m (396 ft) above mean sea level when the river enters the Hanford Site near Vernita, to 104 m (343 ft) where it leaves the Hanford Site near the 300 Area.

Large Columbia River floods have occurred in the past (DOE, 1986a), but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood control/water storage dams upstream from the Hanford Site. The maximum historical flood on record occurred June 7, 1894, with a peak discharge at the Hanford Site of 21,000 m<sup>3</sup> per sec (741,600 ft<sup>3</sup> per sec) (Figure 3-61). The largest recent flood took place in 1948, with an observed peak discharge of 20,000 m<sup>3</sup> per sec (706,300 ft<sup>3</sup> per sec) at the Hanford Site. The probability of flooding at the magnitude of the 1894 and 1948 floods has been greatly lowered because of upstream regulation by dams (Figure 3-60). There have been fewer than 20 major floods on the Yakima River since 1862 (DOE, 1986a).

The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 40,000 m<sup>3</sup> per sec (1,412,600 ft<sup>3</sup> per sec). This flood would inundate the 100 Areas located adjacent to the Columbia River, but the central portion of the Hanford Site would remain unaffected (DOE, 1986a).

The U.S. Army Corps of Engineers evaluated a number of scenarios on the effects of failures of Grand Coulee Dam, assuming flow conditions on the order of 11,000 m<sup>3</sup> per sec (388,500 ft<sup>3</sup> per sec). The discharge resulting from a 50 percent breach at the outfall of Grand Coulee Dam was determined to be 600,000 m<sup>3</sup> per sec (21,188,800 ft<sup>3</sup> per sec). In addition to the areas inundated by the probable maximum flood, the remainder of the 100 Areas, the 300 Area, and nearly all of Richland, WA, would be flooded (DOE, 1986a).

Surface Water Quality: The Washington State Department of Ecology classifies the Columbia River as Class A (excellent) between Grand Coulee Dam and the mouth of the river near Astoria, OR (DOE, 1986a). The Class A designation requires that industrial uses of this water be compatible with other uses, including drinking water, wildlife, and recreation.

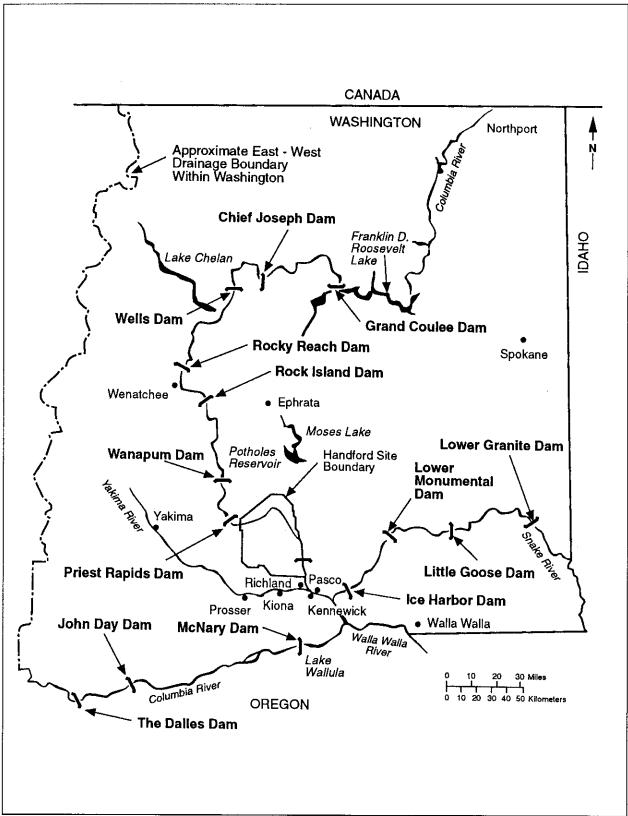


Figure 3-60 Locations of Major Surface Water Resources and Principal Dams within the Columbia Plateau

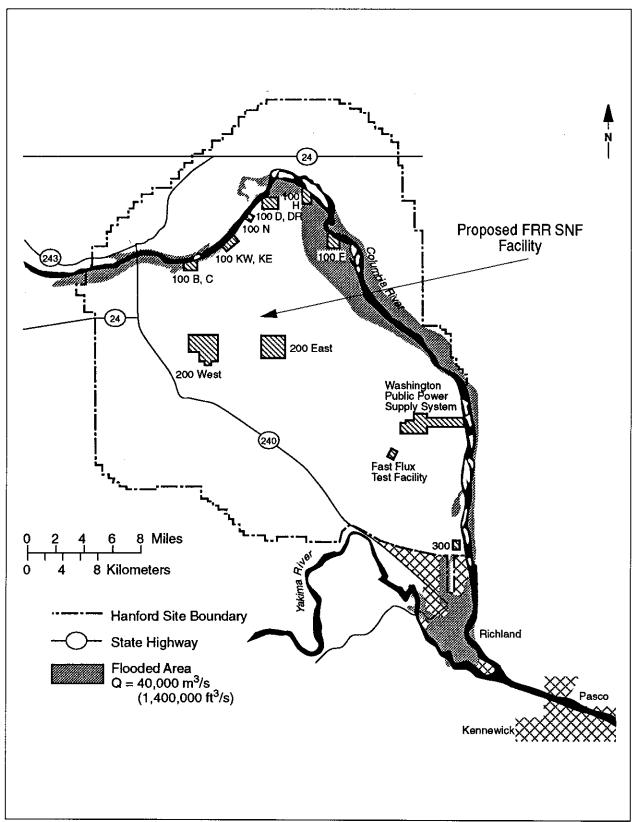


Figure 3-61 Flood Area for the Probable Maximum Flood

Radiological monitoring shows low levels of radionuclides in samples of Columbia River water. Hydrogen-3 (tritium), iodine-129, and uranium are found in slightly higher concentrations downstream from the Hanford Site than upstream (DOE, 1995c), but were well below concentration guidelines established by DOE and U.S. Environmental Protection Agency drinking water standards. Cobalt-60 and iodine-131 were not consistently found in measurable quantities during 1987 samples of Columbia River water from Priest Rapids Dam, the 300-Area water intake, or the Richland City pumphouse. The average annual strontium-90 concentrations were essentially the same at Priest Rapids Dam and the Richland Pumphouse for 1987, and were well below the State of Washington and U.S. Environmental Protection Agency drinking water standards.

## 3.3.3.3.2 Groundwater

Groundwater under the Hanford Site occurs in unconfined and confined conditions. The unconfined aquifer is contained within the glaciofluvial sands and gravel and within the Ringold Formation. The bottom of the aquifer is the basalt surface or, in some areas, the clay zones of the lower member of the Ringold Formation. The confined aquifers consist of sedimentary interbeds and/or interflow zones that occur between dense basalt flows in the Columbia River Basalt Group. The main water-bearing portions of the interflow zones occur within a network of interconnecting vesicles and fractures of the flow tops or flow bottoms.

Sources of natural recharge to the unconfined aquifer are rainfall and runoff from the higher bordering elevations, water infiltrating from small ephemeral streams, and river water along influent reaches of the Yakima River and Columbia River.

From the recharge areas to the west, the groundwater flows downgradient to the discharge areas, primarily along the Columbia River. This general west-to-east flow pattern is interrupted locally by the groundwater mounds in the 200 Areas. From the 200 Areas, there is also a component of groundwater flow to the north between Gable Mountain and Gable Butte. These flow directions represent current conditions; the aquifer is dynamic and responds to changes in natural and artificial recharge.

Local recharge to the shallow basalts is believed to result from infiltration of precipitation and runoff along the margins of the Pasco Basin. Regional recharge of the deep basalts is thought to result from interbasin groundwater movement originating northeast and northwest of the Pasco Basin in areas where the Wanapum and Grande Ronde Basalts crop out extensively. Groundwater discharge from the shallow basalt is probably to the overlying unconfined aquifer and the Columbia River. The discharge area(s) for the deep groundwater is currently uncertain, but flow is believed to be generally southeastward with discharge speculated to be south of the Hanford Site (DOE, 1986a).

Groundwater Quality: The groundwater composition is that of a dilute (less than or approximately 350 mg per L total dissolved solids) calcium-bicarbonate chemical type. Other principal chemical constituents include sulfate, silica, magnesium, and nitrate (the latter contributed through the disposal of chemical reprocessing waters).

Contamination of the groundwater is caused by releases from various liquid-waste disposal facilities. Nitrate and tritium contamination has migrated away from these sites in a general west-to-east direction. Some longer-lived radionuclides such as strontium-90 and cesium-137 have reached the groundwater, primarily through liquid-waste disposal cribs. Small quantities of longer-lived radionuclides have reached the water table via a failed groundwater monitoring well casing and through reverse well injection, a disposal practice which was discontinued at the Hanford Site in 1947 (DOE, 1995c).

Areal and stratigraphic changes in groundwater chemistry characterize basalt groundwaters beneath the Hanford Site (Graham et al., 1981). The stratigraphic position of these changes is believed to delineate flow system boundaries, and to identify chemical evolution taking place along groundwater flow paths. Overall, waters of the shallow basalts are of a sodium-bicarbonate chemical type, while those of the deep basalts are of a sodium-chloride chemical type (DOE, 1986a). Iodine-129 and tritium have been detected in confined groundwater in the Saddle Mountains Basalt beneath the Hanford Site (DOE, 1986a).

## 3.3.3.4 Meteorology

The Hanford Site is located in a semi-arid region of southeastern Washington State. A summary of the following data (through 1980) has been published (Stone et al., 1983).

Wind: Prevailing wind directions on the 200-Area Plateau are from the northwest in all months of the year. Monthly and annual joint frequency distributions of wind direction versus wind speed for the Hanford Meteorological Station have been recorded (Stone et al., 1983). Monthly average wind speeds are lowest during the winter months, averaging 10 to 11 km per hr (6.2 to 6.8 mph), and highest during the summer, averaging 14 to 16 km per hr (8.7 to 9.9 mph). High winds are also associated with thunderstorms. The average occurrence of thunderstorms is 10 per year. Although thunderstorms are most frequent during the summer, they have occurred in each month (DOE, 1995c). It is estimated that the probability of a tornado striking a point at the Hanford Site is 0.0000096 per year, or less than one in one-hundred thousand.

Temperature and Humidity: Diurnal and monthly averages and extremes of temperature, dew point, and humidity have been recorded (Stone et al., 1983). Ranges of daily maximum and minimum temperatures vary from normal maxima of 2°C (35.6°F) in early January to 35°C (95°F) in late July. The record maximum temperature is 46°C (114.8F), and the record minimum temperature is -32.8°C (-27.0°F). The annual average relative humidity at the Hanford Meteorological Station is 54 percent. It is highest during the winter months, averaging about 75 percent, and lowest during the summer, averaging about 35 percent.

Precipitation: Average annual precipitation at the Hanford Meteorological Station is 16 cm (6.3 in). Most of the precipitation occurs during the winter, with nearly half of the annual amount occurring in the months of November through February. Winter monthly average snowfall ranges from 0.8 cm (0.3 in) in March to 13.5 cm (5.3 in) in January. Snowfall accounts for about 38 percent of all precipitation during the months of December through February.

Atmospheric Dispersion: Good dispersion conditions associated with neutral and unstable stratification exist about 57 percent of the time during the summer.

Air Quality: Air quality in the vicinity of the Hanford Site is generally classified as quite good. Wind-eroded dust, resulting from plowed fields and arid terrain with sparse vegetation, is an occasional problem in the area. The atmospheric conditions that produce the dust are favorable to pollutant transport and diffusion.

## **3.3.3.5** Ecology

The Hanford Site is made up of relatively large, undisturbed (1,450 km², about 560 mi²) expanses of shrub-steppe desert that contain numerous plant and animal species suited to the region's semi-arid environment. The Hanford Site consists of mostly undeveloped land, with facilities only occupying about 6 percent of the total available area. Most of the Hanford Site has not experienced tillage or livestock grazing since the early 1940's.

The Hanford Site vegetation has been characterized as a shrub-steppe (DOE, 1995c) with relatively low productivity. In the early 1800s, the dominant plant was the big sagebrush with an understory of perennial bunchgrasses, but with the advent of livestock and crop raising, the natural vegetation was overtaken by what is today the dominant plant, cheatgrass. Some planted trees exist and serve as nesting platforms for several species of birds, including hawks, owls, ravens, magpies, and great blue herons, and as night roosts for wintering bald eagles (Rickard and Watson, 1985). Today, the vegetation picture at the Hanford Site consists of eight major kinds of plant communities: sagebrush/bluebunch wheatgrass, sagebrush/cheatgrass or sagebrush/Sandberg's bluegrass, sagebrush-bitterbrush/cheatgrass, greasewood/cheatgrass-saltgrass, winterfat/Sandberg's bluegrass, thyme buckwheat/Sandberg's bluegrass, cheatgrass-tumble mustard, willow or riparian, spiny hopsage, and sand dunes. More than 600 species of plants have been identified at the Hanford Site (Sackschewsky et al., 1992). A distribution of the dominant plant communities is shown in Figure 3-62.

More than 300 species of terrestrial and aquatic insects have been found on the Hanford Site. Grasshoppers and darkling beetles are among the more conspicuous groups, and along with other species, are important in the food web of the local birds and mammals. Approximately 12 species of amphibians and reptiles are known to exist on the Hanford Site (Fitzner and Gray, 1991). The most abundant reptile is the side-blotched lizard, although short-horned and sagebrush lizards are also seen frequently. Also common are gopher snakes, yellow-bellied racers, the Pacific rattlesnake, toads, and frogs.

More than 125 species of birds have been identified on the Hanford Site (Rogers and Rickard, 1977). The horned lark and western meadowlark are the most abundant nesting birds in the shrub-steppe. The Hanford Site supports populations of chukar partridge, gray partridge, and sage grouse, with the greatest concentration in the Rattlesnake Hills. Wastewater ponds at the Hanford Site are important habitats for songbirds, shore birds, ducks, and geese. The most important waterfowl is the Canada goose. Hawks and owls use the Hanford Site as a refuge, especially during nesting (DOE, 1995c).

Approximately 39 species of mammals have been identified on the Hanford Site (Fitzner and Gray, 1991). Most are small and nocturnal. Of this group, the Great Basin pocket mouse is the most abundant, and others include the deer mouse, Townsend ground squirrel, pocket gopher, harvest mouse, Norway rat, sagebrush vole, grasshopper mouse, vagrant, Leasts chipmunk, and Merriam vole. Larger mammals include the mule deer and elk. The largest vertebrate predator inhabiting the Hanford Site is the coyote. A herd of wild, free-roaming elk is centered almost entirely on the Arid Lands Ecology Reserve, a part of the Hanford Site established as an environmental research study area in 1968.

The Columbia River is the dominant aquatic ecosystem, and the river supports a large and diverse community of plankton, benthic invertebrates, fish, and other communities. Plankton populations in the Hanford reach are influenced by communities that develop in the reservoir of upstream dams, with phytoplankton and zooplankton populations being largely transient, flowing from one reservoir to another. Phytoplankton species include diatoms, golden or yellow-brown algae, red algae, and dinoflagellates. Zooplankton populations in the Hanford reach of the Columbia are generally sparse. All major freshwater benthic taxa are represented in the river. Forty-three species of fish had been identified in the river (DOE, 1995c), and since then the brown bullhead has been collected, bringing the number to 44. Of these, the Chinook salmon, sockeye salmon, coho salmon, and steelhead trout use the river as a migration route to and from upstream spawning areas, and are of the greatest economic importance. Small spring streams contain diverse biotic communities and are extremely productive, consisting of dense blooms of watercress and aquatic insects. Temporary wastewater ponds and ditches on the Hanford Site develop riparian communities and become quite attractive to migrating birds in autumn and spring.

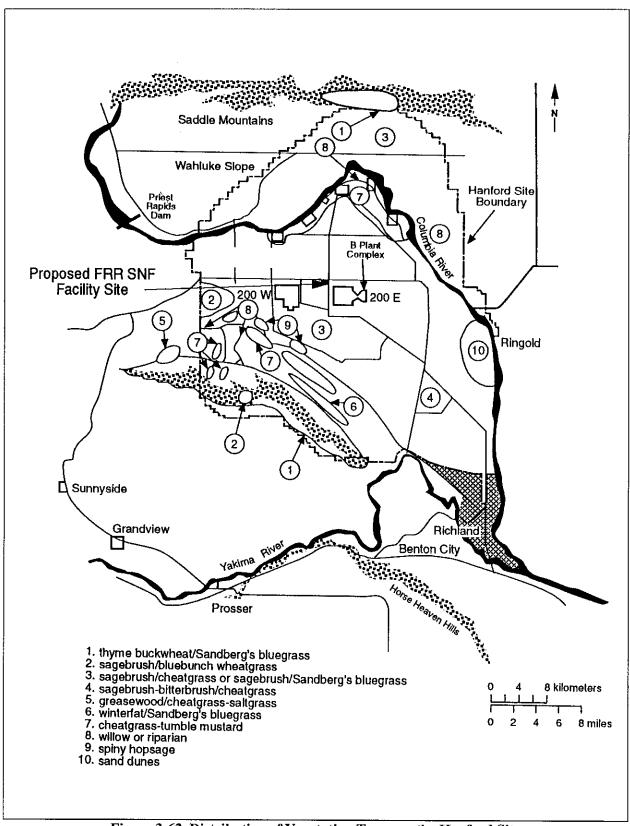


Figure 3-62 Distribution of Vegetation Types on the Hanford Site

Threatened, Endangered, and Candidate Plant and Animal Species: Threatened and endangered species, as listed by both the Federal Government and the State of Washington, are shown in Table 4.9-1 of Appendix A, Volume 1 of the Programmatic SNF&INEL Final EIS (DOE, 1995c). No plants or mammals on the Federal list are known to occur on the site. There are, however, several species of plants and animals that are under consideration for formal listing. Two species of plants are included in the State listing. Columbia milk-vetch, found on dry land benches along the river, is listed as threatened, and yellowcress, found on the wetted zone of the water's edge, is designated as endangered. The Federal Government lists the American peregrine falcon as endangered and the bald eagle as threatened. The State of Washington lists (in addition to the peregrine falcon and bald eagle) the white pelican and sandhill crane as endangered, and the ferruginous hawk as threatened. The peregrine falcon is a casual migrant to the Hanford Site and does not nest there. The bald eagle is a regular winter resident, foraging on dead salmon and waterfowl along the river, but not nesting on the Hanford Site. Ferruginous hawks have increasingly used power poles for nesting sites. Mammals considered endangered by the State are the pygmy rabbit, the Merriam shrew, the pallid bat, and the long-eared myotis.

Several small spring streams, wetlands, temporary water bodies, and national and State wildlife refuges are located on, or adjacent to, the Hanford Site.

#### 3.3.3.6 Land Use

The Hanford Site encompasses  $1,450~{\rm km}^2~(560~{\rm mi}^2)$ , and includes several DOE operational areas. The major areas are:

- The entire Hanford Site, which has been designated a National Environmental Research Park;
- The 100 Areas, bordering on the right bank (south shore) of the Columbia River, which are the sites of the eight retired plutonium production reactors. The 100 Areas occupy about 11 km<sup>2</sup> (4.2 mi<sup>2</sup>);
- The 200-West and 200-East Areas are located on a plateau about 8 and 11 km (5.0 and 6.8 mi), respectively, from the Columbia River. For some time, these areas have been dedicated to fuel reprocessing and waste processing management and disposal activities. The 200 Areas cover about 16 km<sup>2</sup> (6.2 mi<sup>2</sup>);
- The 300 Area, located just north of the city of Richland, is the site of nuclear research and development and nuclear fuel fabrication. This area covers 1.5 km<sup>2</sup> (0.6 mi<sup>2</sup>);
- The 400 Area covers about 0.6 km<sup>2</sup> (0.25mi<sup>2</sup>) and is about 8 km (5 mi) north of the 300 Area and is the site of the Fast Flux Test Facility used in the testing of breeder reactor systems. Also included in this area is the Fuels and Material Examination Facility;
- The 600 Area includes all of the Hanford Site not occupied by the 100, 200, 300, or 400 Areas. Land uses within the 600 Area include:
  - The Arid Lands Ecology Reserve, a 310 km<sup>2</sup> (120 mi<sup>2</sup>) tract set aside for ecological studies,
  - 4 km<sup>2</sup> (1.5 mi<sup>2</sup>) leased by the State of Washington, part of which is used for low-level radioactive waste disposal,

- 4.4 km<sup>2</sup> (1.7 mi<sup>2</sup>) for Washington Public Power Supply System nuclear power plants,
- 2.6 km<sup>2</sup> (1.0 mi<sup>2</sup>) transferred to the State of Washington as a potential site for the disposal of nonradioactive hazardous wastes,
- About 130 km<sup>2</sup> (50 mi<sup>2</sup>) under revocable use permit to U.S. Fish and Wildlife Refuge,
- 225 km² (87 mi²) under revocable use permit to the Washington State Department of Game for recreational game management,
- Support facilities for the controlled access areas, and
- Laser Intercrometer Gravitational Wave Observatory.

Surrounding the Hanford Site, 660 km<sup>2</sup> (255 mi<sup>2</sup>) have been designated for Arid Lands Ecology Reserve, U.S. Fish and Wildlife Refuge, and Washington State Department of Game (DOE, 1986a).

Land use in other areas includes urban and industrial development, irrigated and dry-land farming, and grazing. In 1985, wheat represented the largest single crop in terms of area planted in Benton and Franklin counties with 116,145 ha (287,000 acres). Corn, alfalfa, hay, and barley are other major crops in Benton and Franklin counties.

In 1986, the Columbia Basin Project, a major irrigation project to the north of the Tri-Cities (Richland, Pasco, and Kennewick), produced gross crop returns of \$343 million, representing 19 percent of all crops grown in Washington State. In 1986, the average gross crop value per irrigated ha was \$1,640 (\$664 per irrigated acre). The largest percentages of irrigated acres produced alfalfa hay (29.4 percent of irrigated acres), wheat (15.0 percent), and corn (feed grain) (9.4 percent). Other significant crops are potatoes, apples, dry beans, asparagus, and pea seed.

## 3.3.3.7 Noise

Studies at the Hanford Site dealing with the propagation of noise have dealt primarily with occupational noise at work sites. Environmental noise levels have not been extensively evaluated because of the remoteness of most the Hanford activities, and isolation from receptors that are covered by Federal or State statutes. This discussion will focus on what little environmental noise data is available. The majority of available information consists of model predictions, which in many cases have not been verified, since these predictions indicate that the potential to violate Federal or State standards is remote or unrealistic.

The Noise Control Act of 1972 and its subsequent amendments (Quiet Communities Act of 1978, 42 USC 4901-4918, 40 CFR 201-211) directs the regulation of environmental noise to the State. The State of Washington has adopted RCW 70.107, which authorizes the Department of Ecology to implement rules consistent with Federal noise control legislation. RCW 70.107 and the implementing regulations embodied in WAC 173-60 through 173-70 define the regulation of environmental noise levels. Maximum noise levels are defined for the zoning of the area for the environmental designation for noise abatement. The Hanford Site is classified as a Class C environmental designation for noise abatement area on the basis of industrial activities. Unoccupied areas are also classified as Class C areas by default, because they

are neither Class A (residential) nor Class B (commercial). Maximum noise levels are established based on the environmental designation for noise abatement classification of the receiving area and the source area (DOE, 1995c).

## 3.3.3.8 Transportation

The Tri-Cities serve as a regional transportation and distribution center with major air, land, and river connections. The Tri-Cities area has direct rail service, provided by Burlington Northern and Union Pacific, which connects the area to more than 35 States (Figure 3-63). Union Pacific operates the largest fleet of refrigerated railcars in the United States, and is essential to food processors that ship frozen food from this area. Passenger rail service is provided by Amtrak, which has a station in Pasco.

The Hanford Site infrequently uses docking facilities at the ports of Benton on the Columbia River. No barge accidents were reported in 1988 (DOE, 1995c).

Daily air passenger and freight services connect the area with most major cities through the Tri-Cities Airport in Pasco. The airport is currently served by two commuter-regional and two national airlines. The main runway is 2,350 m (7,755 ft) in length, and can accommodate landings and takeoffs by medium-range commercial aircraft, such as the Boeing 727-200 and Douglas DC-9. Two additional airports, located in Richland and Kennewick, are limited to serving private aircraft.

The Tri-Cities are linked to the region by five major roads. Route 395 joins the area with Spokane to the northeast. Both route 395 and route 240, which crosses through the Hanford Site, connect with Interstate 90 to the north. Route 12 links the region with Yakima to the northwest, Lewiston, ID to the east, and Walla Walla to the southeast. Finally, the area is linked to Interstate 84 to the south, via Interstate 82 and Route 14. Routes 240 and 24 traverse the Hanford Site and are maintained by the State of Washington. Other roads within the Hanford Site are maintained by DOE.

### 3.3.3.9 Socioeconomics

The level of operations at the Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities and other parts of Benton and Franklin counties. The agricultural community also has a significant effect on the local economy. Any major changes in the Hanford Site operations will affect the Tri-Cities and other areas of Benton and Franklin counties.

Three major sectors have been the principal driving forces of the economy in the Tri-Cities since the early 1970's: (1) DOE and its contractors operating the Hanford Site, (2) Washington Public Power Supply System in its construction and operation of nuclear power plants, and (3) the agricultural community, including a substantial food processing component. Most of the goods and services produced by these sectors are exported outside the Tri-Cities. In addition to direct employment and payrolls, these major sectors also support a sizable number of jobs in the local economy through their procurement of equipment, supplies, and business services. Three other components can be identified a contributors to the economic base of the Tri-Cities economy. These include other employers, such as: (1) Siemens Nuclear Power Corporation in North Richland, (2) Sandvik Special Metals in Kennewick, and (3) Boise-Cascade's Wallula corrugated paper mill, tourism, and Government transfer payments in the form of pension benefits.

The Hanford Site dominates the local employment picture with more than one-quarter of the total nonagricultural jobs in Benton and Franklin counties (15,552 out of 64,300), so the Hanford Site payroll impacts the Tri-Cities and State economy. In 1991, the Hanford Site employment accounted directly for

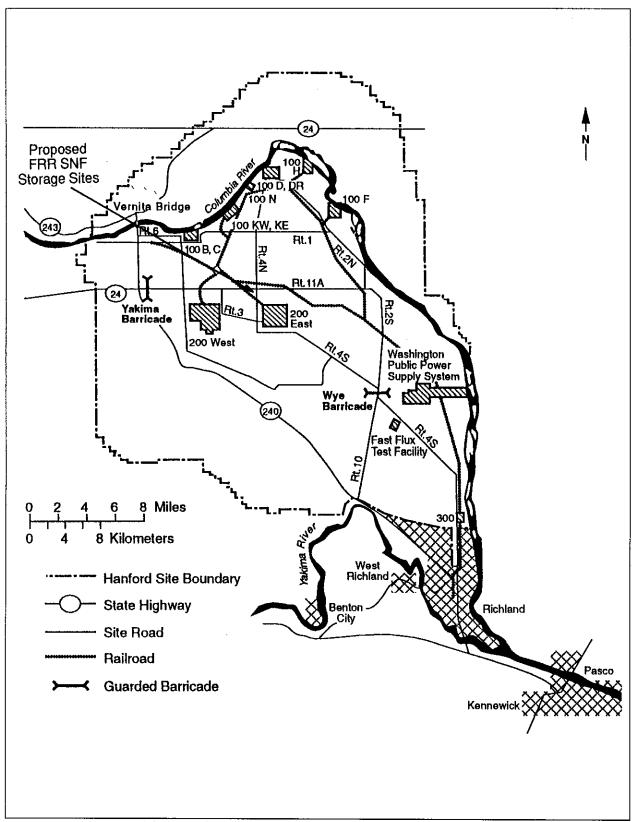


Figure 3-63 Transportation Routes on the Hanford Site

24 percent of total nonagricultural employment in Benton and Franklin counties, and slightly more than 0.6 percent of all nonagricultural Statewide jobs. In 1991, the Hanford Site operations directly accounted for an estimated 42 percent of the payroll dollars earned in the area.

The Washington Public Power Supply System continues to be a major employer in Richland, with more than 1,700 workers and an approximate \$71.6 million in payroll during the year. In 1990, agriculture was responsible for nearly 12,900 jobs, nearly 17 percent of total employment. This includes about 2,200 farm proprietors accounting for \$121 million in crop and livestock production which provides 7,600 wage and salary jobs, and "agri-business" (farm and ranch supporting activities such as application of fertilizers, sales of farm supplies and equipment, etc.) accounting for 900 jobs. Employment in the food processing sector included 20 food processors producing potato products, canned fruits and vegetables, wine, and animal feed.

Other major employers include about 3,500 workers in Benton and Franklin counties. Tourism has increased in the area, and overall tourism expenditures in the Tri-Cities were roughly \$77.5 million in 1990. In 1990, 15,903 people over the age of 65 resided in Benton and Franklin counties. This segment of the population supports the local economy on the basis of income received from Government transfer payments and pensions, private pension benefits, and prior individual savings. A summary of estimated major Government pension benefits received by the residents of Benton and Franklin counties in 1990 is shown in Table 4.3-7 of Appendix A, Volume 1 of the Programmatic SNF&INEL Final EIS (DOE, 1995c). The estimated income of this component of the basic sector is roughly equivalent to the entire agricultural sector.

Estimates by the U.S. Bureau of the Census for 1990 place Benton and Franklin counties' population totals at 112,560 and 37,473, respectively. Within each county, the 1990 estimates distribute the Tri-Cities population as follows: Richland, 32,315; Kennewick, 42,159; and Pasco, 20,337. The 1990 estimates of racial categories by the Bureau of the Census indicate that in Benton and Franklin counties, Asians represent a lower proportion, and individuals of Hispanic origin represent a higher proportion of the racial distribution than those in the State of Washington. Fifty-six percent of the population of Benton and Franklin counties is under the age of 35, compared to 54 percent for the State of Washington, and the 65-yr-old and older group constitutes 10 percent of the population, compared to 12 percent for the State.

Social and economic impacts of the Hanford Site operations are concentrated in Benton County, Franklin County, and the Tri-Cities area made up of Pasco, Richland, and Kennewick. The region of influence for the Hanford Site is represented by the 80 km (50 mi) radius around the site. Figure 3-64 represents the general ethnic characteristics of the population within the 80 km (50 mi) radius. Low income data for the region of influence is shown in Figure 3-65. A low-income household is one with an income of 80 percent or lower than the median income of the county. Approximately 42 percent of the households in the region of influence are low income families.

In 1990, nearly 92 percent of all housing (38,781 total units) in the Tri-Cities was occupied. Single-unit housing, which represents nearly 58 percent of the total units, has a 96 percent occupancy rate. Multiple-unit housing has an occupancy rate of nearly 91 percent. Pasco has the lowest occupancy rate, 89 percent in all categories of housing, followed by Kennewick (93 percent) and Richland (94 percent). Representing nine percent of the housing unit types, mobile homes have an 81 percent occupancy rate.

Primary and secondary education are served by the Richland, Kennewick, Pasco, and Kiona-Benton school districts. In 1992, spring enrollment for all districts was approximately 24,876 students. Post-secondary education in the Tri-Cities area is provided by a junior college, Columbia Basin College, and the Tri-Cities branch campus of Washington State University.

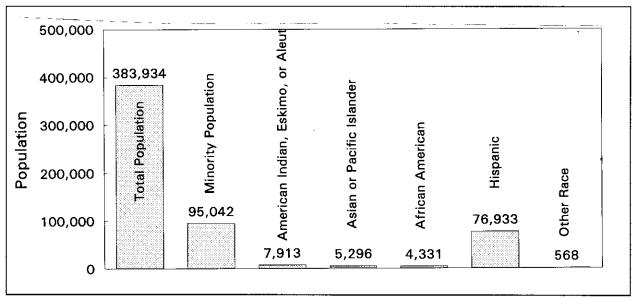


Figure 3-64 Racial and Ethnic Composition of the Minority Population Residing within 80 km (50 mi) of the Hanford Site

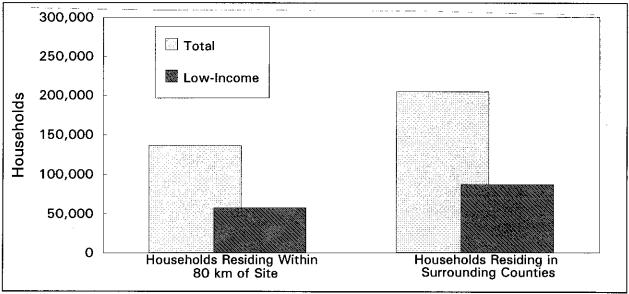


Figure 3-65 Low-Income Households Residing within 80 km (50 mi) of the Hanford Site

The Tri-Cities have three major hospitals and four minor emergency centers. Kadlec Medical Center, located in Richland, has 136 beds and functions at an average of 39.5 percent capacity. Kadlec Medical Center's 5,754 annual admissions represent more than 42 percent of the Tri-Cities market. Kennewick General Hospital maintains an average 45.5 percent occupancy rate of its 71 beds with 3,619 admissions. Our Lady of Lourdes Hospital, located in Pasco, reports an average occupancy rate of 36.5 percent.

Police and fire protection in Benton and Franklin counties is provided by Benton and Franklin county sheriff's departments, local municipal police departments, and the Washington State Patrol Division, headquartered in Kennewick. The Hanford Fire Patrol is composed of 126 trained firefighters.

The principal source of water in the Tri-Cities and the Hanford Site is the Columbia River, from which the water systems of Richland, Pasco, and Kennewick draw a large portion of the average 43 billion liters (11.4 billion gal) used in 1991. Electricity is provided by the Benton County Public Utility District, Benton Rural Electric Association, Franklin County Public Utility District, and city of Richland Energy Services Department. In the Pacific Northwest, hydropower, and to a lesser extent, coal and nuclear power, constitute the region's electrical generation system. Throughout the 1980's, the Northwest had more electric power than it required, and was operating at a surplus. This surplus has been exhausted, and there is only approximately enough power supplied by the existing system to meet the current electricity needs.

### 3.3.3.10 Historical, Archaeological, and Cultural Resources

The Hanford Site is rich in cultural resources, and contains numerous well-preserved archaeological sites representing both prehistoric and historical periods. The area is considered a homeland by many Native Americans.

More than 10,000 years of prehistoric human activity in the Middle Columbia River region have left extensive archaeological deposits along river shores (DOE, 1995c) and well-watered areas inland from the river (DOE, 1995c; Greene, 1975;). Graves are common in various settings, and spirit quest monuments are found on high, rocky summits (Rice, 1968). By virtue of their inclusion in the Hanford Site, from which the public is restricted, archaeological deposits found in the Hanford reach of the Columbia River, on adjacent plateaus, and mountains have been spared some of the disturbances that have befallen other sites.

There are currently 248 prehistoric archaeological sites recorded in the files of the Washington State Office of Archaeology and Historic Preservation. Forty-seven of these sites are included on the National Register of Historic Places, two as single sites (45BN121, the Hanford Island Site; 45GR137, Paris Site), and the rest in seven archaeological districts. In addition, a nomination has been prepared for one cultural district (Gable Mountain/Gable Butte), and a renomination for two additional archaeological districts is pending (Wahluke, Coyote Rapids). Two other sites, 45BN90 and 45BN412, are considered eligible for the National Register. Archaeological sites include remains of numerous pithouse villages, various types of open campsites, and cemeteries along the riverbanks (DOE, 1995c), spirit quest monuments, hunting camps, game drive complexes and quarries in mountains and rocky bluffs, hunting/kill sites in lowland stabilized dunes, and small temporary camps near perennial sources of water located away from the river (Rice, 1968).

Native American people of various tribal affiliations have populated the Hanford reach of the Columbia River since prehistoric and early historic times. Wanapums and Yakama people of the Chamnapum band, and some of their descendants still live nearby, while others have been incorporated into the Yakama and Umatilla Reservations. Palus people, who lived on the lower Snake River, joined the Wanapum and Chamnapum to fish the Hanford reach and inhabited the river's west bank (DOE, 1995c). Walla Walla and Umatilla people also made periodic visits to the area to fish. These groups retain traditional and secular ties to the region, with native plant and animal foods, some found on the Hanford Site, being used in ceremonies. Certain landmarks, especially Rattlesnake Mountain, Gable Mountain, Gable Butte, Goose Egg Hill and others along the river are considered sacred. The many cemeteries found along the river are considered sacred by these groups.

Two hundred-two historic archaeological sites and 11 other historic localities have been recorded in the published literature. Localities include the Allard Pumping Plant at Coyote Rapids, the Hanford Irrigation Ditch, the Hanford townsite, Wahluke Ferry, the White Bluffs townsite, the Richmond Ferry, Arrowsmith

townsite, a cabin at East White Bluffs ferry landing, the White Bluffs road, the old Hanford high school, and the Cobblestone Warehouse at Riverland (DOE, 1995c). In addition to recorded sites, numerous data from additional unrecorded sites, including homesteads, corrals, and dumps, have been recorded by the Hanford Cultural Resources Laboratory since 1987. The 100-B Reactor has been listed on the National Register of Historic Places. Other Manhattan Project facilities remain to be evaluated.

## 3.3.4 Description of the Affected Environment at the Oak Ridge Reservation

The Oak Ridge Reservation is a key DOE site hosting three separate facilities with missions including basic and applied research and development; storage of special nuclear materials; weapons dismantlement, storage, and evaluation; and environmental restoration and waste management. The site is operated for DOE by Martin Marietta Energy Systems. This section describes the potentially affected environment at the Oak Ridge Reservation.

### 3.3.4.1 **Geology**

The Oak Ridge Reservation lies within the western portion of the Valley and Ridge Province, near the boundary with the Cumberland Plateau, in the State of Tennessee (Figure 3-66). The Valley and Ridge Province is characterized by numerous linear ridges and valleys that trend approximately southwest-northeast. A generalized geologic map of the Oak Ridge Reservation is shown in Figure 3-67. The Oak Ridge Reservation is mostly underlain by the Rome Formation and Conasauga, Knox, and Chickamauga Groups, sedimentary rocks of Cambrian and Ordovician age. A detailed description of these formations is given in the Programmatic SNF&INEL Final EIS (DOE, 1995c).

Sinkholes, large springs, caves, and other karst features are common in the Knox Group, and those parts of the Oak Ridge Reservation underlain by limestones and dolomites are classified as karst terrains. Although no site-specific geologic characterization has been conducted at the West Bear Creek Valley site, it appears that the proposed site for the construction of a foreign research reactor spent nuclear fuel storage facility is located over the lower Conasauga Group strata not normally characterized by karst development.

The soils found in the Oak Ridge Reservation vicinity generally contain clay minerals, chert, and quartz sand (Hatcher et al., 1992). Soils on the Oak Ridge Reservation tend to retain moisture, and are typically 90 percent saturated below a depth of 3 m (10 ft) (Ketelle and Huff, 1984). Depth of soil profiles on the Oak Ridge Reservation vary from 15 cm (5.9 in) on slopes, to 18 m (60 ft) over dolomites in the Knox Group (Boyle et al., 1982).

#### 3.3.4.2 Seismology and Volcanology

The Oak Ridge Reservation is located in a region of moderate seismic activity, having an average of one to two earthquakes per year, with seismic activity occurring in bursts followed by long periods of inactivity. From 1811 to 1975, only five major earthquakes or earthquake series have affected the Oak Ridge Reservation area. No deformation of recent surface deposits has been detected, and seismic shocks from the surrounding, more seismically active areas, are dissipated by distance from the epicenters (Boyle et al., 1982). During the 1811 to 1975 period, none of the earthquakes were of a magnitude that caused severe damage to buildings or structures.

The underlying structure of the Oak Ridge Reservation is complex due to the extensive faulting and deformation characteristic of the region. There are three regional thrust faults in the Oak Ridge Reservation area, the Kingston, Whiteoak Mountain, and Copper Creek Faults. All three strike to the

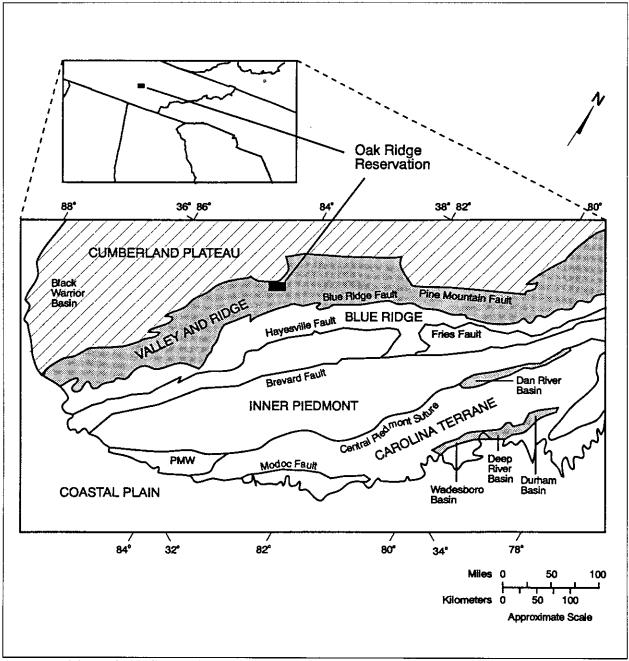


Figure 3-66 Generalized Map of the Southern Appalachian Geologic Provinces Showing the Location of the Oak Ridge Reservation

northeast and dip to the southeast. The most recent movement on the faults was during the Late Pennsylvanian/Early Permian periods (280 to 290 million years ago), and consequently, the faults are not considered to be capable at present (Butz, 1984).

There is no evidence that there has been significant volcanic activity in the vicinity of the Oak Ridge Reservation for more than 1 million years (DOE, 1995c). Three studies conducted specifically for the Oak Ridge Reservation have been summarized (Beavers et al., 1982).

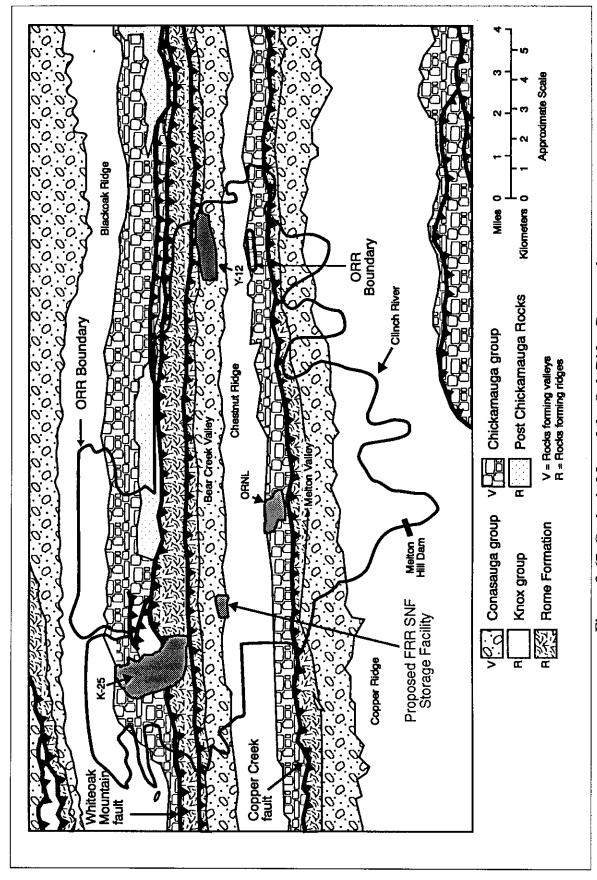


Figure 3-67 Geologic Map of the Oak Ridge Reservation

# 3.3.4.3 Hydrology

### **3.3.4.3.1** Surface Water

The hydrologic system on the Oak Ridge Reservation is controlled by the Clinch River (MMES, 1993a). Its drainage area is about 11,422 km² (4,410 mi²) (Boyle et al., 1982). All water that drains from the Oak Ridge Reservation enters the Clinch River, and subsequently the Tennessee River. Flow in the Clinch-Tennessee river system is regulated by multi-purpose dams of the Tennessee Valley Authority.

The Oak Ridge Reservation is drained by a network of tributaries of the Clinch River. A Statewide stream classification system based on water quality, water use, and resident aquatic biota designates most streams on the Oak Ridge Reservation for fish and aquatic life, irrigation and livestock watering (MMES, 1993b). The drainage pattern on the Oak Ridge Reservation is a weakly developed "trellis" pattern (Lee and Ketelle, 1987), and the surface drainage patterns are also affected by karst topography.

Heavy precipitation in the area causes localized flooding, primarily in the city of the Oak Ridge (MMES, 1993a) and along the Clinch River. Figure 3-68 shows approximate 500-yr floodplains. A number of wetlands occur on the Oak Ridge Reservation (MMES, 1993b), including characteristic forested wetlands along creeks, wet meadows and marshes associated with streams and seeps, and emergent communities in shallow embayments and ponds.

Surface Water Quality: Water quality in the Clinch River is affected by the Oak Ridge Reservation activities, by contaminants introduced upstream from the Oak Ridge Reservation, and by flow regulation at the Tennessee Valley Authority dams. Stream impoundment has resulted in a rise in water temperatures, sediment retention, and contaminant adsorption.

The Clinch River supplies most of the water to the Oak Ridge Reservation, the city of Oak Ridge, and other cities along the river (MMES, 1993a). Major water uses in the Oak Ridge area include withdrawals for industrial and public water supplies, commercial and recreational navigation, and other recreational activities such as fishing, boating and swimming. Water for the city of Oak Ridge is withdrawn upstream from any of the Oak Ridge Reservation discharge points. Five public water supplies, including the cities of Kingston and Harriman, TN, are located downstream of the Oak Ridge Reservation (MMES 1993a). These are located 4 km (2.5 mi) above and 34 km (21 mi) below the mouth of Poplar Creek, respectively.

### 3.3.4.3.2 Groundwater

Groundwater beneath the Oak Ridge Reservation is heavily influenced by the site geologic structure (Solomon et al., 1992). Geologic units of the Oak Ridge Reservation are assigned to two broad hydrologic groups, Knox Aquifer and the Oak Ridge Reservation aquitards. These aquitards may store fairly large volumes of water, but they transmit only limited amounts.

The Knox Aquifer is the only true aquifer of the Oak Ridge Reservation, and is the primary source of sustained natural flow in perennial streams (Solomon et al., 1992). Flow volumes and potential groundwater flow path length in the Knox Aquifer are greater than in the aquitard. No spent nuclear fuel management facilities would be sited in areas overlying the Knox aquifer.

Recently published reports such as "Status Report; A Hydrologic Framework for the Oak Ridge Reservation", and "Status Report on the Geology of the Oak Ridge Reservation" have all used the term "aquitard" to describe the Pumpkin Valley Shale and a number of the other geologic units beneath the Oak Ridge Reservation. No site-specific data are available to determine at what depth Pumpkin Valley Shale is

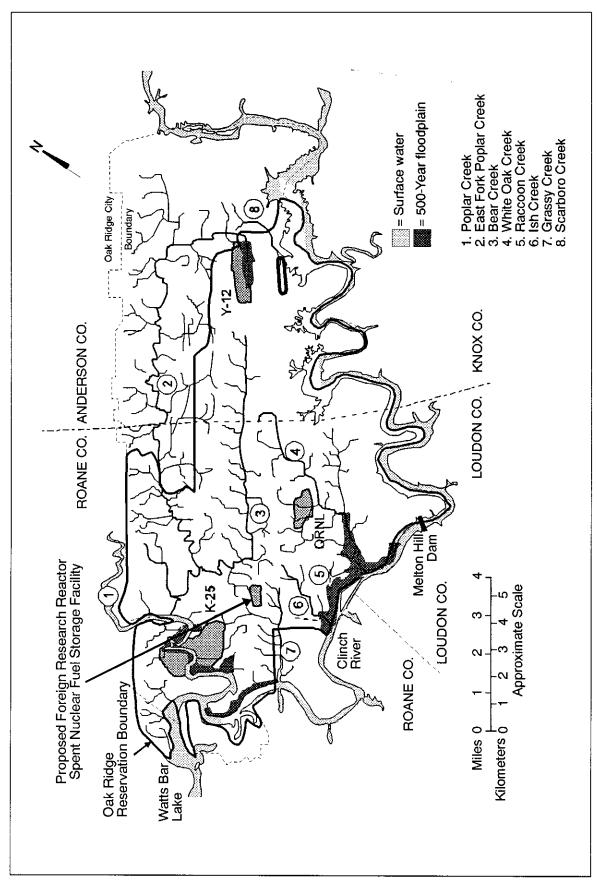


Figure 3-68 Locations of the Clinch River and Tributaries on the Oak Ridge Reservation

encountered at the West Bear Creek Valley, the proposed site for the construction of foreign research reactor spent nuclear fuel storage facilities. It would be logical, however, to think that at depths of 18 m (60 ft) or less on the site, the water-bearing unit most likely to be encountered would be an aquitard (DOE, 1995c).

Groundwater Quality: Background groundwater quality at the Oak Ridge Reservation is generally good in the surficial aquifer zones, and poor in the bedrock aquitards at depths greater than 305 m (1,000 ft) (DOE, 1993d). Groundwater has been contaminated downgradient from waste management facilities and other industrial sources, and discharge of contaminated groundwater has introduced contaminants to streams. Principal groundwater contaminants that exceed applicable standards at the Y-12 Plant include volatile organics, nitrates, heavy metals, and radioactivity (MMES, 1993b). There is one known instance of offsite migration of contaminants from the Oak Ridge Reservation. In 1994, DOE announced that elevated levels of four industrial solvents (carbon tetrachloride, chloroform, tetrachloroethylene, and trichloroethylene) had been detected in the Knox Aquifer monitoring wells east of the Y-12 Plant (Bowdle, 1994). The same solvents are found in groundwater monitoring wells within the Y-12 Plant.

There are no sole-source aquifers beneath the Oak Ridge Reservation (DOE, 1993d). Water rights are not an issue in the region. All groundwater at the Oak Ridge Reservation is classified as Class II (current and potential sources of drinking water and those waters having other beneficial uses).

Although surface water sources provide the main portion of potable water supplies in the area, groundwater does provide for some domestic, municipal, farm, irrigation, and industrial use (MMES, 1993b). Single-family wells are common in areas not served by public water supplies (MMES, 1992). Due to the abundance of surface water and its proximity to the points of use, almost no groundwater is used at the Oak Ridge Reservation (DOE, 1993d).

### 3.3.4.4 Meteorology

The Oak Ridge Reservation is located within the Great Valley of Tennessee, in which Cumberland Plateau borders to the northwest and the Great Smoky Mountains lie to the southeast. The climate at the Oak Ridge Reservation is influenced by these terrain features.

Wind: The wind direction above the ridgetops and within the valleys tends to follow the orientation of the valleys. The prevailing wind direction is from the southwest, with a secondary maximum from the northeast during the winter, spring, and summer months. This situation is reversed in the fall. Damaging winds are uncommon in the region. Peak gusts recorded in the Great Valley are generally in the 27 to 31 m per sec (60 to 70 mph) range for the months of January through July, in the 22 to 27 m per sec (50 to 60 mph) range for August, September, and December, and in the 16 to 20 m per sec (36 to 45 mph) range in October and November.

Temperature and Humidity: The average daily temperature at the Oak Ridge National Weather Service Station was 14.2°C (57.6°F) for the period of record 1961-1990. The average daily temperature varied from a low of 2.6°C (36.7°F) in January to a high of 24.8°C (76.6°F) in July. The mean relative humidity was 86 percent, with the mean monthly maximum of 92 percent occurring in July and August, and the mean monthly minimum of 80 percent occurring during February and March.

Precipitation: Winter is the wettest of the seasons in the Oak Ridge Reservation area, March and December are the wettest months, and October is the driest. The maximum monthly precipitation was 48.9 cm (19.3 in) in July, while maximum rainfall in a 24-hr period observed at the Oak Ridge National Weather Service was 19 cm (7.5 in), recorded in August 1960 (DOE, 1995c). The annual average precipitation reported by the National Weather Service for the Oak Ridge was 137.2 cm (54 in).

On average, about 51 thunderstorm days per year are recorded at the Oak Ridge National Weather Service station. The Great Valley of Tennessee is infrequently subject to tornadoes. The western half of the State has experienced three times as many tornadoes as the eastern half, where the Oak Ridge Reservation is located. The Oak Ridge Reservation did experience a tornado from a severe thunderstorm on February 21, 1993. The tornado path passed the Y-12 Plant in an east-northeast direction for approximately 21 km (13 mi), ending just north of Knoxville. The wind speeds associated with this tornado ranged from 18 m per sec (40 mph) to nearly 58 m per sec (130 mph), depending on the location along the path (DOE, 1993c). Hurricanes are rarely sustained once they reach as far inland as the Great Valley, due to the rapid loss of energy.

Atmospheric Dispersion: The transport and dispersion of airborne material are direct functions of air movement. The atmospheric conditions are unstable (Stability Classes A through C) approximately 5 percent of the time, neutral (Class D) approximately 43 percent of the time, and stable (Classes E through G) approximately 52 percent of the time at the 10 m (33 ft) level.

Air Quality: A summary of the Oak Ridge Reservation airborne radionuclide emissions for 1992 is presented in Table 4.7-1 of Appendix F, Volume 1 of the Programmatic SNF&INEL Final EIS (DOE, 1995c). The maximum effective dose equivalent at the Oak Ridge Reservation boundary is 3.3 mrem as calculated by the GENII code. This is 33 percent of the National Emissions Standards for Hazardous Air Pollutants.

The Oak Ridge Reservation is located in Anderson and Roane Counties in the Eastern Tennessee-Southwestern Virginia Interstate Air Quality Control Region 207. As of 1993, the areas within this Air Quality Control Region were designated as attainment with respect to all National Ambient Air Quality Standards (40 CFR 81.343).

### 3.3.4.5 **Ecology**

Land for the Oak Ridge Reservation was primarily in agricultural use, including woodlots and woodlands used for pasture, at the time of acquisition by DOE's predecessor agencies. At least half of the Oak Ridge Reservation was forested. Most of the forest had been partially cut for timber, but not completely cleared on steep slopes. Natural plant communities have re-established themselves on most of the Oak Ridge Reservation, although many areas are maintained as pine plantations or nonforested areas (ORNL, 1988). Approximately 10 percent of the Oak Ridge Reservation has been developed since it was withdrawn from public access, and the remainder of the site has reverted to or been planted with natural vegetation (MMES, 1989).

The vegetation of the Oak Ridge Reservation has been categorized into seven plant communities (Parr and Pounds, 1987). The Oak Hickory forest is one of the most extensive plant communities on the Oak Ridge Reservation. Another abundant plant community is the Pine Hardwood forest and Pine plantations. A total of 899 species, subspecies, and varieties of plants have been identified on the Oak Ridge Reservation (Cunningham and Pounds, 1991). The Oak Ridge Reservation also provides habitat for a large number of animal species. Twenty-six species of amphibians, 33 species of reptiles, 169 species of birds, and 39 species of mammals have been recorded at the Oak Ridge Reservation (Parr and Evans, 1992).

Vegetative communities of the West Bear Creek site are typical of the Oak Ridge Reservation as a whole, composed of second-growth oak-hickory forest and mixed pine-hardwood forest. There are some loblolly pine plantations adjacent to the northern edge of the powerline right-of-way and between the right-of-way and Bear Creek Road (Rosensteel, 1994). Fauna of the site would also be similar to those expected throughout the Oak Ridge Reservation.

Wetlands on the Oak Ridge Reservation include emergent, scrub/shrub, and forested wetland located in embayments of the Melton Hill and Watts Bar Reservoirs that border the Oak Ridge Reservation, along all the major streams, including East Fork Poplar Creek, Poplar Creek, Bear Creek, and their tributaries, in old farm ponds, and around groundwater seeps. Originating on the lower slopes of Pine Ridge are several headwater tributary systems on Grassy Creek that flow from north to south across the West Bear Creek site. The stream valleys contain forested wetlands.

Aquatic habitats on or adjacent to the Oak Ridge Reservation range from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams.

A National Environmental Research Park Aquatic Reference Area is located along Grassy Creek and its tributaries, one of which runs through the eastern portion of the proposed spent nuclear fuel management site. Grassy Creek has a diverse assemblage of invertebrates and fish species for a stream its size. The Oak Ridge Reservation uses Grassy Creek as a reference area for studies of other streams affected by site development (Pounds et al., 1993).

Threatened, Endangered, and Candidate Plant and Animal Species: No animal species listed by the Federal Government as threatened or endangered are known to reside on the Oak Ridge Reservation (Kroodsma, 1987). The bald eagle is a winter visitor to Watts Bar Lake and Melton Hill Lake. None of the species listed in Table 4.9-1 of Appendix F, Volume 1 of the Programmatic SNF&INEL Final EIS have been recorded on the proposed West Bear Creek Valley site (DOE, 1995c). Table 4.9-1 of Appendix F, Volume 1 of the Programmatic SNF&INEL Final EIS lists Federally and State-listed threatened, endangered or other special-status species designated by the Endangered Species Act and/or the State's Nongame and Endangered Species and the Rare Plant Protection and Conservation laws (DOE, 1995c). Preferred habitat within the site indicates a greater potential for occurrence of the barn owl, black vulture, Cooper's hawk, red-shouldered hawk, and sharp-shinned hawk (DOE, 1995c). No intensive threatened and endangered species surveys have been completed for the site, but they are currently in progress for the entire the Oak Ridge Reservation (King et al., 1994).

### 3.3.4.6 Land Use

The Oak Ridge Reservation occupies an area of approximately 14,029 ha (34,667 acres) in eastern Tennessee, in a predominantly rural area about 40 km (25 mi) west of Knoxville. The Oak Ridge Reservation is within the jurisdictional boundaries of the city of Oak Ridge, and also lies within Roane and Anderson Counties (MMES, 1989).

Land use activities at the Oak Ridge Reservation have historically occurred within the boundaries of the three main plant sites (Y-12, the Oak Ridge National Laboratory, and K-25). The Oak Ridge Reservation has been used by research institutions, universities, and Government agencies as a site for the study of terrestrial ecology, aquatic ecology, forestry, and agriculture. Land uses bordering the Oak Ridge Reservation are primarily forest and agricultural. Residential and commercial are the only other significant uses of land in the vicinity, and occur along the northeast and northwest boundaries of the Oak

Ridge Reservation in the city of Oak Ridge. Figure 3-69 shows the land use in and around the Oak Ridge Reservation. The entire Oak Ridge Reservation has been placed under the forestry, agriculture, industry, and research zoning classification by the city of Oak Ridge. This classification does not bind DOE land use decisions on the site.

The region surrounding the Oak Ridge Reservation has numerous local, State, and national public recreation areas. Several lakes exist within the region surrounding the Oak Ridge Reservation, offering year-round recreational activities such as fishing and boating. The Oak Ridge Reservation is a controlled area, with public access limited to through traffic on Tennessee State Routes 95, 58, 62, 162, and 170 (MMES, 1991). There are no onsite areas that are subject to Native American Treaty rights or that contain any prime or unique farmland.

#### 3.3.4.7 Noise

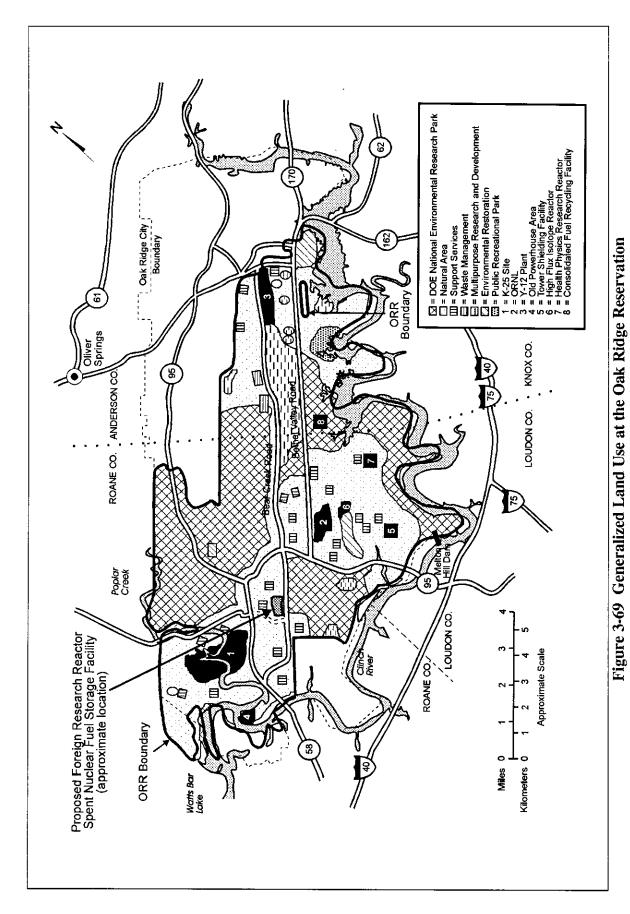
The major noise sources within the Oak Ridge Reservation occur primarily in developed operational areas and include various facilities, equipment, and machines. Major noise sources outside the operational areas consist primarily of vehicles and railroad operations. At the site boundary, noise from these sources would be barely distinguishable from background noise levels. The State of Tennessee has not established specific numerical environmental noise standards applicable to the Oak Ridge Reservation. The acoustic environment along the Oak Ridge Reservation site boundary is typical of a rural location, with the average soundlevel in the range of 35 to 50 decibels, A-weighted.

# 3.3.4.8 Transportation

The region of influence for the Oak Ridge Reservation includes site roads and regional roads up to approximately 24 km (15 mi) in Anderson, Blount, Knox, Loudon, and Roane counties. Primary roads on the Oak Ridge Reservation include Tennessee State Routes 95, 58, 62, 162, and 170 (Bethel Valley Road), and Bear Creek Road. Except for Bear Creek Road east of Route 95, all are public roads. The remaining roads on the Oak Ridge Reservation are private. Interstates 75 and 40, and Tennessee State Routes 162, 62, and 61 form a loop around the Oak Ridge Reservation (Figure 3-70).

Current baseline traffic (i.e., 1994) along segments providing access to the Oak Ridge Reservation is projected to contribute to differing service level conditions (TDOT, 1991). Tennessee State Route 61 would operate at level of service D between Interstate 75 at Norris and U.S. Route 25W at Clinton, and at level of service C between U.S. Route 25W at Clinton to Tennessee State Route 62 east of Oliver Springs. Tennessee State Routes 58 and 170 (providing access from the east), as well as Bear Creek Road, would operate between levels of service C and A. Tennessee State Routes 62 and 95 would operate at widely varying levels of service in the vicinity of the Oak Ridge Reservation. Tennessee State Route 62 would operate at a level of service E between Tennessee State Route 95 at Oak Ridge and Tennessee State Route 170 between Tennessee State Route 162. Tennessee State Route 95 would operate at a level of service E between Tennessee State Route 61 and Tennessee State Route 62 at Oak Ridge.

No public transportation service exists on the Oak Ridge Reservation. Other modes of transportation within the region of influence include railways and waterways. Railroad service in the region of influence is provided by CSX Transportation and the Norfolk Southern Corporation. Waterborne transportation is via the Clinch River. The Clinch River waterway has rarely been used for DOE business, and no designated port facilities exist for such purposes (U.S. Army Corps of Engineers, 1994).



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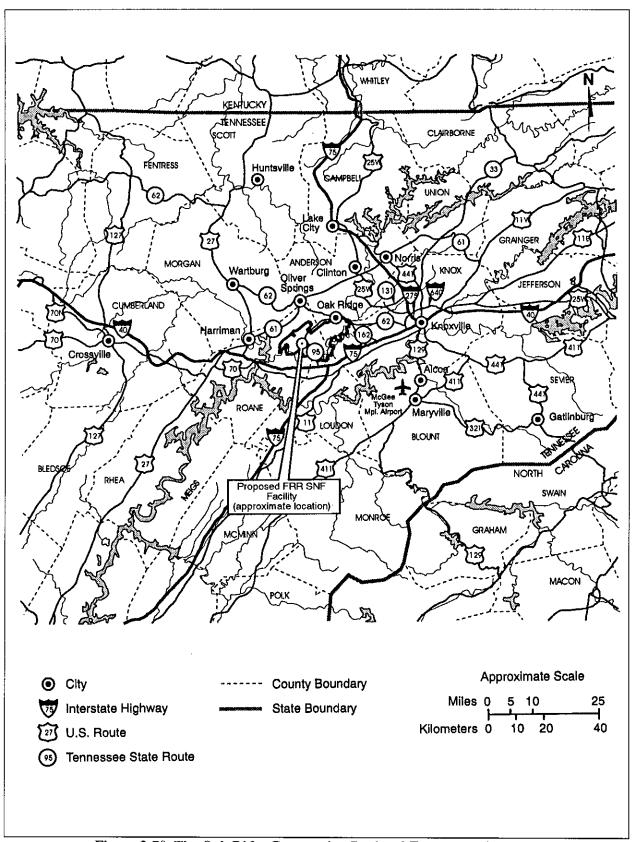


Figure 3-70 The Oak Ridge Reservation Regional Transportation Map

McGhee Tyson Airport in Knoxville, 64 km (40 mi) from the Oak Ridge Reservation, receives jet air passenger and cargo services from both national and international carriers. The closest air transportation facility to the Oak Ridge Reservation is Atomic Airport in Oliver Springs. Numerous other private airports are located throughout the region of influence (DOE, 1995c).

## 3.3.4.9 Socioeconomics

The region of influence includes the current residential distribution of DOE and contractor personnel employed by the Oak Ridge Reservation, the probable location of offsite contractor operations, and the probable location of labor and capital supporting indirect economic activity linked to the Oak Ridge Reservation. The region of influence includes the counties where 92 percent of DOE and contractor personnel employed by the Oak Ridge Reservation reside.

Regional economic linkage supporting production activity at the Oak Ridge Reservation occurs primarily with Anderson, Knox, Loudon, and Roane counties, where most of the offsite supporting contractors and labor and capital supporting indirect economic activity linked to the Oak Ridge Reservation are located. The total population of the region of influence is projected to be 489,230 persons in 1995 (DOE, 1995c), and is projected to grow at an annual average rate of less than 1 percent, reaching 538,820 persons in 2004. The labor force is also projected to grow at an annual average rate of less than 1 percent, growing to 360,000 persons in 2004. The total employment is projected to grow at an annual average rate of approximately 1 percent, growing from 292,700 jobs in 1995 to 338,070 jobs in 2004.

Figure 3-71 shows the racial and ethnic composition of minorities within 80 km (50 mi) of spent nuclear fuel management sites on the Oak Ridge Reservation. In comparison with the other four candidate sites, the Oak Ridge Reservation has the smallest percentage, about 6 percent, of minorities in the population residing around the site. African Americans make up approximately 76 percent of the minority population, while Hispanics and Asian Americans make up 8 to 9 percent of the minority population.

Figure 3-72 presents the low-income households residing within 80 km (50 mi) of the Oak Ridge Reservation. About 44 percent of the households are classified as having an income no larger than 80 percent of the median income for the county of residence. This percentage is typical of that for counties within 80 km (50 mi) of the spent nuclear fuel management sites.

The Oak Ridge Reservation fire protection services are provided by the fire departments on the reservation. The Oak Ridge Reservation fire departments have mutual aid agreements among themselves and with the city of Oak Ridge (DOE, 1995c). Twelve city, county, and State law enforcement agencies provide police protection in the region of influence. Law enforcement on the Oak Ridge Reservation is provided by the city of Oak Ridge Police Department. Security enforcement is provided by the prime management and operations contractor (MMES, 1989). Four county school districts (Anderson, Knox, Loudon, and Roane) and five city school districts (Clinton, Oak Ridge, Lenoir City, Kingston, and Harriman) provide public education services in the region of influence. In 1992, the nine school districts had an average daily membership of 75,825 students. Between 1980 and 1990, the number of housing units in the region of influence increased 14 percent from 181,299 to 206,234. In 1980 and 1990, the homeowner vacancy rates in the region of influence averaged 1.4 and 1.5 percent, respectively (DOE, 1995c).

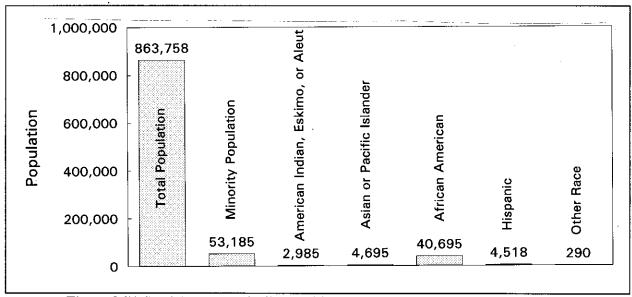


Figure 3-71 Racial and Ethnic Composition of the Minority Population Residing within 80 km (50 mi) of the Oak Ridge Reservation

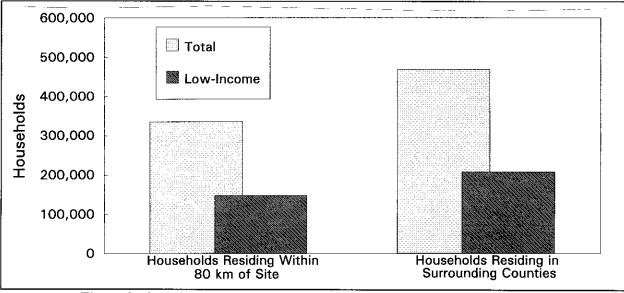


Figure 3-72 Low-Income Households Residing within 80 km (50 mi) of the Oak Ridge Reservation

# 3.3.4.10 Historical, Archaeological, and Cultural Resources

A limited survey conducted in 1975 did not identify any cultural resources on the Oak Ridge Reservation at the West Bear Creek Valley site (DOE, 1995c). No prehistoric or historic resources are expected to be located on the site. There are no known Native American resources on the proposed site.

## 3.3.5 Description of the Affected Environment at the Nevada Test Site

The Nevada Test Site is primarily used for the development and testing of nuclear weapons. This section describes the potentially affected environment of the site. The location of the site is shown in Figure 3-73.

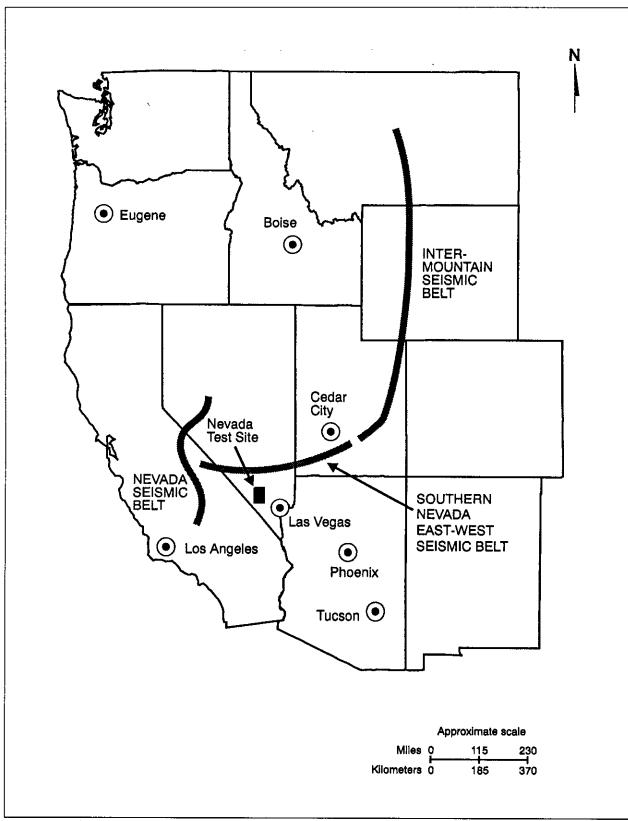


Figure 3-73 Location of the Nevada Test Site in Relation to the Nevada Seismic Belt, the Intermountain Seismic Belt, and the Southern Nevada East-West Seismic Belt

### **3.3.5.1** Geology

The Nevada Test Site is located east and north of the Walker Lane-Las Vegas Valley Shear Zone (Eckel, 1968). Walker Lane is a northwest-trending belt of right-lateral faults that disrupts the regional structural grain in the southwestern part of the Great Basin along the California-Nevada border. The Las Vegas Valley Shear Zone is a concealed zone of right-lateral faulting along the north side of the Las Vegas Valley (DOE, 1988a). The local geology of the Nevada Test Site is characterized by mountain ranges composed of Precambrian and Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas that surround alluvium-filled, topographically closed valleys. A geologic map of the site is shown as Figure 3-74 (DOE, 1993b). The sedimentary rocks are complexly folded and faulted, and are composed mainly of carbonates (dolomite and limestone) in the upper and lower parts of the column and clastics (shale and sandstone) in the middle section. The volcanic rocks are predominantly tuffs that are high in silica.

Faulting generally occurs as thrust faults, normal faults, and strike-slip faults (DOE, 1992c). The faults are shown in Figure 3-75 (DOE, 1993b). Thrust faulting occurs as three major thrust faults, and normal faults exist in both ranges and valleys and generally strike northeast and northwest. The nearest strike-slip structure to the Nevada Test Site is the Walker Lane-Las Vegas Valley Shear Zone. Estimates of horizontal displacement along this shear zone range from 40 to 160 km (25 to 100 mi) (DOE, 1982). Recent displacements have occurred along several faults as a consequence of underground nuclear explosions. This disturbance is not attributable to naturally-occurring seismic activity. Fault displacements are thought to have occurred as a result of the added stress produced by the explosions, the vibrations produced by the explosions, or a combination of both (Eckel, 1968). Almost all of the natural fault movement in the Nevada Test Site area occurred several million years ago, except movement along Yucca Fault. Movement in the Yucca Fault is believed to have occurred in the past tens of thousands to 250,000 years (DOE, 1982; DOE, 1995c).

## 3.3.5.2 Seismology

The Nevada Test Site lies on the southern margin of the Southern Nevada East-West Seismic Belt (Figure 3-73), which is an area of relatively low historical seismicity. The regional seismicity is dominated by high-levels of seismic activity. Between 1978 and 1981, no earthquakes with magnitudes greater than 4.3 were recorded (DOE, 1986b). In 1992, a magnitude 5.6 earthquake was recorded near Little Skull Mountain at a depth of 12 km (7.5 mi). In 1993, a magnitude 3.5 earthquake was recorded southeast of the town of Mercury on the Nevada Test Site (DOE, 1995c).

The most probable source for seismic activity at the Nevada Test Site is the Cane Spring fault (Figure 3-75). Estimates of recurrence intervals for major earthquakes in the region are on the order of 25,000 years. For magnitudes of greater than or equal to 6, recurrence intervals are on the order of 2,500 years, and for magnitudes of greater than or equal to 5, recurrence intervals are on the order of 250 years (DOE, 1986b).

### 3.3.5.3 Hydrology

## 3.3.5.3.1 Surface Water

The drainage basins and the generalized directions of surface water flow near the Nevada Test Site are shown in Figure 3-76 (USAF et al., 1991). The boundary lines of the drainage basins occur principally along topographic divides (DOE, 1988a). Almost all streamflow in the Nevada Test Site area is

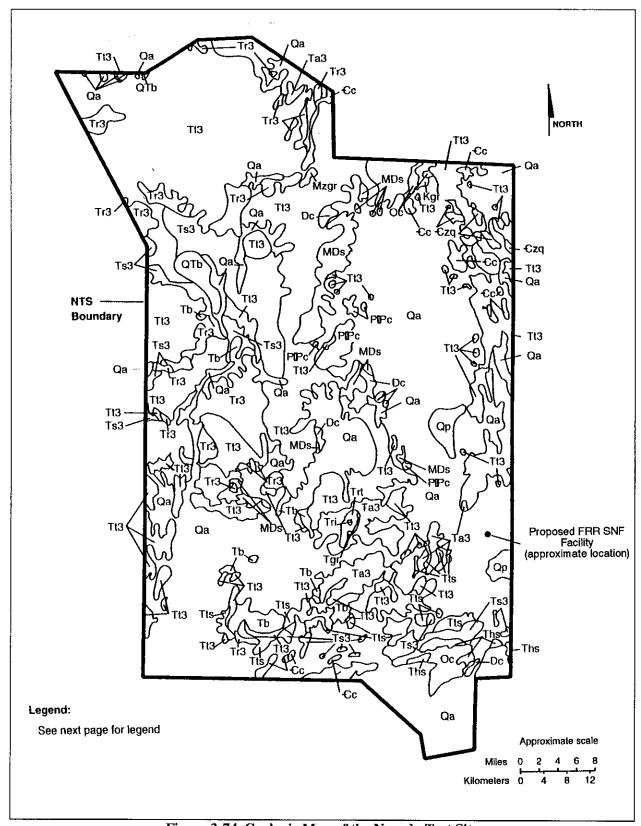
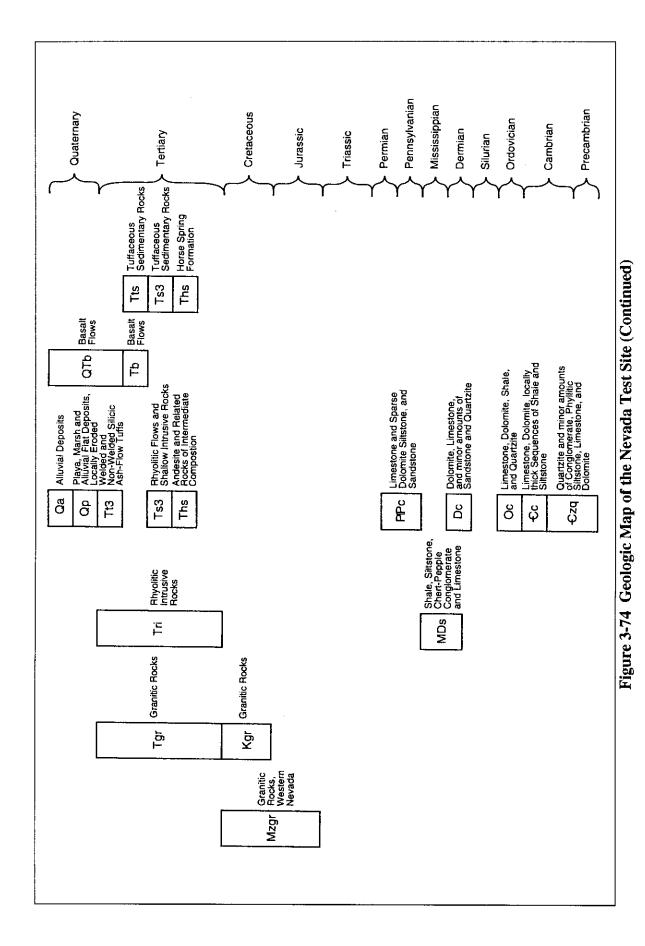


Figure 3-74 Geologic Map of the Nevada Test Site



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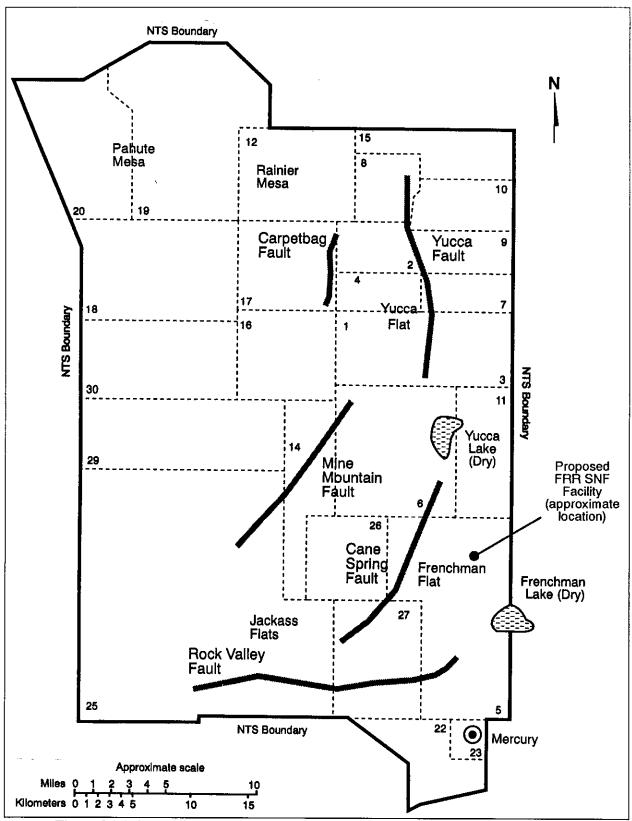


Figure 3-75 Approximate Location of Proposed Facility in Relation to Major Faults at the Nevada Test Site

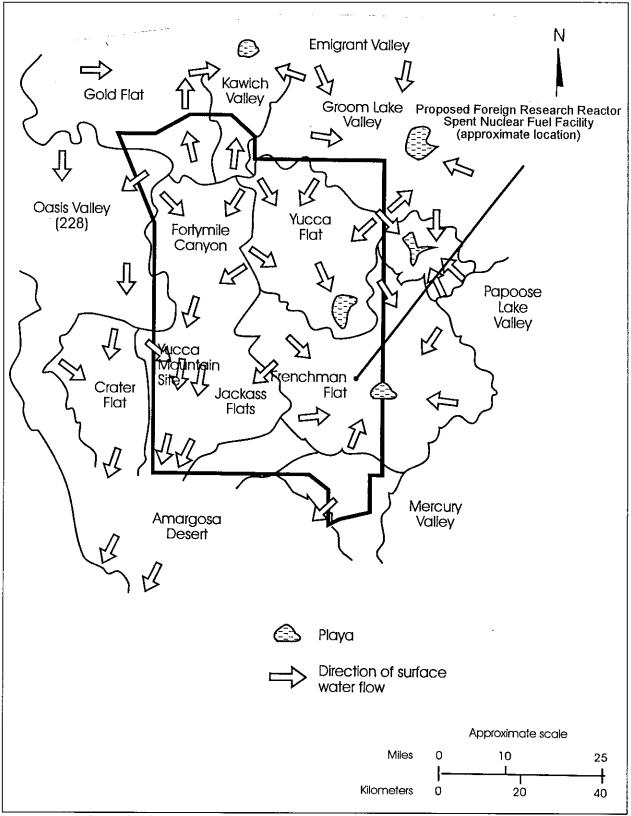


Figure 3-76 The Nevada Test Site Hydrologic Basins and Surface Drainage Direction

ephemeral, and therefore almost no streamflow data have been collected. The ephemeral character of streamflow has also limited the onsite monitoring of surface water quality. Perennial surface water originates from springs, and is restricted to source pools at some large springs. Because of the extreme aridity of this region, most of the spring discharge travels only a short distance before evaporating or infiltrating back into the ground (DOE, 1986b). The western half and southernmost part of the Nevada Test Site have channel systems which carry runoff beyond the Nevada Test Site boundaries during infrequent, very intense storms.

Two watersheds, Fortymile Canyon and Jackass Flats, have the potential for endangering offsite public health and safety due to flooding. Regional peak-flood flow equations for the southern Nevada area indicate that the 100-yr peak flow from the Fortymile Canyon drainage is approximately 370 m<sup>3</sup> per sec (97,744 gal per sec), and 230 m<sup>3</sup> per sec (60,760 gal per sec) from the Jackass Flats drainage (USAF et al., 1991). Underground nuclear testing has resulted in the release of radioactive materials at the land surface. There is the potential for 100-yr floods to transport these contaminants beyond the boundaries of the Nevada Test Site.

### 3.3.5.3.2 Groundwater

The hydrogeology at the Nevada Test Site is characterized by great depths to the groundwater table, and slow velocity of movement of water in the saturated and unsaturated zones (DOE, 1992c). Depth to groundwater varies from about 200 m (660 ft) beneath valleys in the southern part of the Nevada Test Site, to more than 500 m (1,650 ft) beneath Pahute Mesa. Locally, there are perched water tables at shallow depths (USAF et al., 1991). Perched aquifers have been reported at depths of 21 m (70 ft) in the southwestern part of Frenchman Flat. In the eastern portions of the Nevada Test Site, the water table occurs generally in the alluvium and volcanic rocks above the regional carbonate aquifer (DOE, 1993a).

Six major aquifers occur in the area. The hydrologic and geologic properties of these aquifers vary (DOE, 1988a). The lower carbonate and valley fill aquifers are the main sources of groundwater in the eastern part of the Nevada Test Site (DOE, 1986b). Four major aquitards (units tending to retard the flow of groundwater) have been reported in the area (DOE, 1986b).

Regional groundwater flow is from the north and northeast toward the regional discharge area near Ash Meadows in the Amargosa Desert (Figure 3-77). In the western portions of the area, the regional flow is from the northwest to the south and southwest. Groundwater recharge to the Ash Meadows Sub basin occurs primarily from precipitation over the mountainous areas in the northern, eastern, and southern portions of the basin (DOE, 1988a).

The hydrogeologic units that supply potable water to the Nevada Test Site have been classified as Class IIA (currently a source of drinking water) and IIB (potentially a source of drinking water), in accordance with the U.S. Environmental Protection Agency's guidelines for groundwater classification. No aquifers at the Nevada Test Site have been designated as sole-source aquifers.

Groundwater Quality: The quality of the Nevada Test Site groundwater is suitable for most purposes, and generally meets U.S. Environmental Protection Agency secondary standards for major cations and anions, and the primary standards for deleterious constituents. Contamination by radionuclides occurs below the water table as well as in the unsaturated zone above it. This contamination is a result of underground nuclear testing. The principal confirmed or suspected contaminants from these tests include various radionuclides (primarily tritium) and heavy metals.

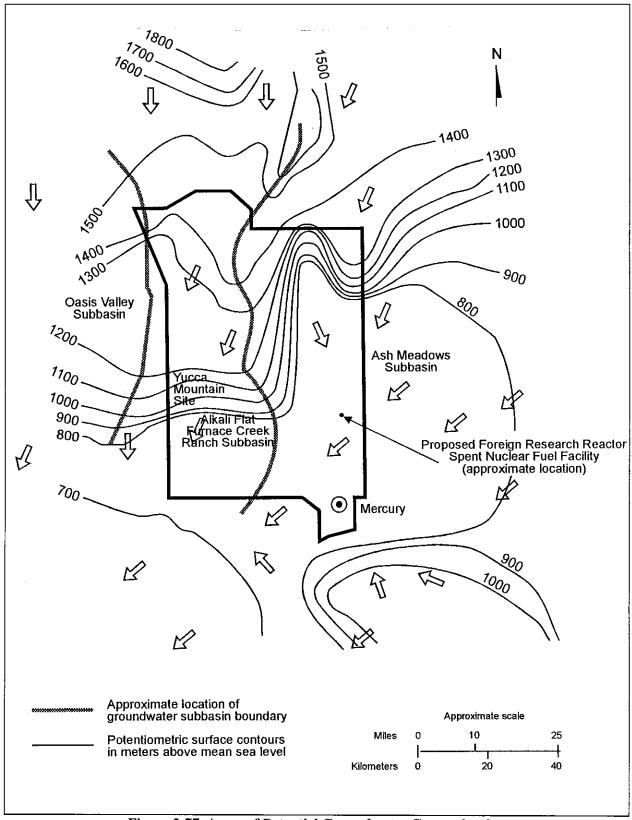


Figure 3-77 Areas of Potential Groundwater Contamination

Groundwater contamination could be transported toward the Nevada Test Site boundary by one of the regional groundwater flow systems. Groundwater flow velocities in these systems range between 1.8 and 183 m per year (6 and 600 ft per year). Due to sorption, most nuclides (other than tritium) would move at a much slower rate. The groundwater travel time from the Nevada Test Site to Ash Meadows Discharge Area is approximately 300 years. Radioactive decay, coupled with dilution and sorption, should reduce radioactivity to well below regulatory limits (USAF et al., 1991). Thus, there are no current effects on public health and safety, nor are any expected in the foreseeable future.

# 3.3.5.4 Meteorology

The climate at the Nevada Test Site and the surrounding region is characterized by high solar radiation, limited precipitation, low relative humidity, and large diurnal temperature ranges. The lower elevations have a climate typical of the Great Basin.

Wind: Low-level surface winds at the Nevada Test Site are influenced by the large-scale weather patterns interacting with the mountain ranges. Predominant winds are from the south during the summer, and the north during the winter. At Las Vegas, the peak wind gust on record is 145 km per hour (90 mph). Strong winds interacting with dry soil conditions are responsible for occasional duststorms or sandstorms.

Temperature and Humidity: At Area 6 (Figure 3-75) of the Nevada Test Site, the average daily maximum/minimum temperatures during the month of January are 10.6°C/-6.1°C (51.1°F/21.0°F). The average daily maximum/minimum temperatures are 35.6°C/13.9°C (96.1°F/57.0°F) in July. At Las Vegas, the coldest temperature on record is -13.3°C (8.1°F), and the warmest temperature on record is 46.7°C (116°F). The average relative humidity at 4 a.m. in Las Vegas is 40 percent. The average relative humidity at 4 p.m. is 20 percent (DOE, 1995c).

*Precipitation*: The average annual precipitation at Area 6 is 15 cm (5.9 in). Precipitation amounts for each month are generally less than 1.3 cm (.5 in). At Las Vegas, the greatest precipitation recorded in a 24-hr period is 6.6 cm (2.6 in). An average of 14 thunderstorm days occur each year, with maximum occurrence in July and August. Thunderstorms occasionally become severe. Tornadoes are extremely rare in Nevada (DOE, 1995c).

Atmospheric Dispersion: Data collected at Desert Rock for calendar year 1990 indicated that atmospheric conditions were unstable (Stability Classes A through C) approximately 25 percent of the time, neutral (Class D) approximately 37 percent of the time, and stable (Classes E through G) approximately 37 percent of the time for that year (DOE, 1995c).

Air Quality: In 1992, the majority of radioactive effluents at the Nevada Test Site originated from underground nuclear tests designed and conducted by two national laboratories and the Defense Nuclear Agency. Onsite monitoring of airborne particulates, noble gases, and tritiated water vapor indicated onsite concentrations that were generally not statistically different from background concentrations. Results of offsite environmental monitoring indicated none of the Nevada Test Site-related radioactivity was detected at any air sampling station, and there were no apparent net exposures detectable by the offsite dosimetry network (DOE, 1993a).

The nonradiological air emissions from the Nevada Test Site originate from concrete batch plants, aggregate crushing and processing, surface disturbance, fire training exercises, motor vehicle operations, boilers, and fuel storage. Based on the data collected by Engineering Science, Inc. at the ambient air monitoring stations, air quality at the Nevada Test Site is within applicable Federal and State standards (DOE, 1995c).

### 3.3.5.5 **Ecology**

The Nevada Test Site lies within the transition area of the Mojave desert and the Great Basin. The Nevada Test Site covers about 3,500 km<sup>2</sup> (1,350 mi<sup>2</sup>), of which only 0.55 percent is developed (DOE, 1988b).

Plant communities on the Nevada Test Site have been classified according to the dominant shrub. Approximately 700 taxa have been identified on the Nevada Test Site (ERDA 1976; DOE, 1991b, DOE, 1993b). Figure 3-78 presents the general plant communities identified on the Nevada Test Site. The dominant plant communities in the Mojave desert are creosote bush. The dominant plant communities in the transition zone between the Mojave desert and the Great Basin are blackbrush, desert thorn, and hopsage. The dominant plant communities in the Great Basin are big sagebrush and black sagebrush, saltbush, and desert thorn.

There are more than 30 species of reptiles and amphibians, 190 species of birds, and 50 species of mammals on the Nevada Test Site (ERDA, 1976; RSN, 1993). Sewage ponds and man-made reservoirs have become an important resource for wildlife. Reptiles and amphibians on the Nevada Test Site include 1 species of desert tortoise, 14 species of lizards, and 17 species of snakes. Birds on the Nevada Test Site are often migratory and seasonal residents. The most-distributed species include the black-throated sparrow, house fin, red-tailed hawk, common raven, loggerhead shrike, mockingbird, ash-throated flycatcher, and mourning dove (Greger, n.d.a.; ERDA, 1976). The most abundant group of mammals on the Nevada Test Site are rodents.

There are several natural springs on the Nevada Test Site that feed flowing streams (Greger, n.d.a.). Vegetation along these channels consists of willow and tamarisk. National Wetlands Inventory maps are not available for the Nevada Test Site (DOE, 1995c).

Potential aquatic habitat on the Nevada Test Site includes surface drainage, playas, man-made reservoirs, and springs. Permanent surface water resources are limited to a few small springs. These surface drainage and playas are unable to support permanent fish populations (ERDA, 1976).

Threatened, Endangered, and Candidate Plant and Animal Species: Table 4.9-1 of Appendix F, Volume 1 of the SNF&INEL Final EIS presents a list of Federally and State-listed species that may be found in the vicinity of the Nevada Test Site (DOE, 1995c). There are no known plants that have been listed as threatened or endangered under the Endangered Species Act on the Nevada Test Site. However, the U.S. Fish and Wildlife Service has identified candidate species for listing, 11 of which may occur on or in the vicinity of the Nevada Test Site. Ten of these are Category 2 species (may be appropriate for listing as endangered or threatened but more information is needed).

Two listed reptile species on or in the vicinity of the Nevada Test Site are of concern. The chuckwalla is a Federal Candidate Category 2 species which may occur on the Nevada Test Site. The desert tortoise is the only Federally listed threatened species known to occur on the Nevada Test Site (DOE, 1995c).

Two bird species (American peregrine falcon and the bald eagle) which could occur on or within the vicinity of the Nevada Test Site are Federally listed endangered species. There are two (spotted bar and pygmy rabbit) Federal Candidate Category 2 mammal species identified as potentially occurring in the vicinity of the Nevada Test Site. There are no known fish species indigenous to the Nevada Test Site.

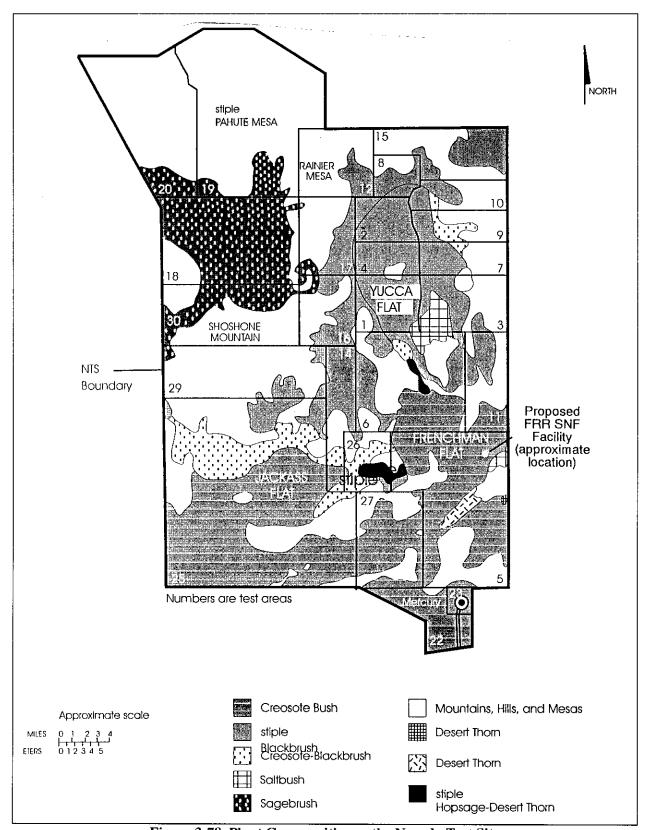


Figure 3-78 Plant Communities on the Nevada Test Site

### 3.3.5.6 Land Use

The Nevada Test Site occupies an area of approximately 3,500 km<sup>2</sup> (1,350 mi<sup>2</sup>) in southern Nevada, in a sparsely populated area approximately 105 km (65 mi) northwest of Las Vegas. The Nevada Test Site is almost entirely surrounded by other Federally-owned lands that buffer it from lands open to the public. The Nevada Test Site is bordered by the Nellis Air Force Range on the north, east, and west, and by Bureau of Land Management lands on the south and southwest (DOE, 1993b).

Existing land use on the Nevada Test Site falls into four general categories: Testing Areas, Buffer/Reserved Areas, Industrial/Research Areas, and Waste Management Areas. According to the latest the Nevada Test Site land use map (Figure 3-79), approximately 50 percent of the land on the Nevada Test Site is buffer/reserved area for ongoing programs or projects (DOE, 1993a).

The Nevada Test Site is located in an area of sparsely vegetated desert. Principal uses in Nye County in the vicinity of the Nevada Test Site include mining, grazing, agriculture, and recreation (DOE, 1993a). Urban and residential land uses occur beyond the immediate vicinity of the Nevada Test Site. Clark County, to the southeast of the Nevada Test Site, consists of approximately 20,460 km<sup>2</sup> (7,900 mi<sup>2</sup>), of which about 95 percent is owned by the Federal Government.

Numerous national, State, and local public recreation areas exist within the Nevada Test Site region. The Nevada Test Site is a controlled area, with public access limited to through traffic on U.S. Route 95, and on Lathrop Wells Road (DOE, 1993a). There are no onsite areas subject to Native American Treaty rights or that contain any prime or unique farmland (PIC, 1992).

### 3.3.5.7 Noise

The major noise sources at the Nevada Test Site occur primarily in developed operational areas, and include various facilities, equipment and machines, aircraft operations, and testing. No Nevada Test Site environmental noise survey data are available (DOE, 1995c). At the Nevada Test Site boundaries, noise from most sources is barely distinguishable from background noise levels. Transportation of people and materials to and from the Nevada Test Site is the noise source of importance to the public. During a normal work week about 3,300 employees travel to the Nevada Test Site each day (DOE, 1995c).

## 3.3.5.8 Transportation

Vehicular access to the Nevada Test Site is provided by U.S. Route 95 to the south, with off-road access to the northeast provided via Nevada State Route 375. Nevada State Route 375 and U.S. Route 95 are projected to remain at Level of Service A (free flow of traffic). The public transit serves the populated regions of Clark County. Contract buses run to the Nevada Test Site. There is no public transportation system serving the Nevada Test Site, but 70 buses a day transport employees to and from the site.

The nearest railroad is the Union Pacific, located approximately 80 km (50 mi) east of the Nevada Test Site near Las Vegas. No navigable waterways are capable of accommodating waterborne transportation of material shipments to the Nevada Test Site. McCarran International Airport in Las Vegas provides jet air passenger and cargo service from both national and local carriers.

### 3.3.5.9 Socioeconomics

A Nevada Test Site worker residential distribution survey from 1988 indicates that 88 percent lived in Clark County and 10 percent in Nye County (DOE, 1995c). In Clark County, most of the Nevada Test Site employees reside in the Las Vegas vicinity.

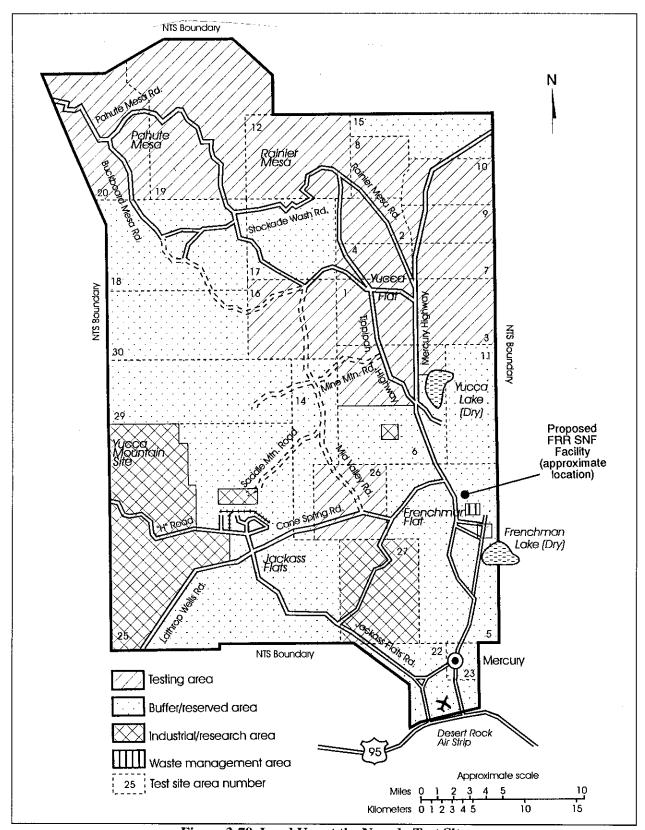


Figure 3-79 Land Use at the Nevada Test Site

Clark County: Clark County is composed of five incorporated cities (Las Vegas, Henderson, North Las Vegas, Boulder City, and Mesquite), and large expanses of unincorporated land. The area experiencing the majority of the county's development is the Las Vegas Valley (DOE, 1995c). Economic conditions in southern Nevada have improved continuously since the mid-1980's. The economy is driven by the growth in the hotel and gaming industry. Service employment accounts for nearly 45 percent of total employment, trade employment accounts for 21 percent, and Government and construction each account for an additional 10 percent (DOE, 1995c).

The unemployment rate reached a low of 4.9 percent in 1990, and increased to 7.5 percent as of June, 1993. However, the unemployment level is expected to decrease with new hotel, gaming, and amusement properties which opened at the end of 1993 (DOE, 1993a).

Nye County: The employment level in Nye county is low relative to Clark County, and includes opportunities in the services, mining, and Government sectors (DOE, 1993a). Nye County is sparsely populated, with the two largest population groupings in the communities of Pahrump and Tonopah. While tourist activity is an important part of the Nye County economy in communities along U.S. 95, mining is the major, even dominant, economic force.

The Nevada Test Site: The Nevada Test Site work force supports engineering design, construction, and operation of the site. As of January 1994, there were a total of 8,563 (3,286 on Nevada Test Site, 3,805 in Las Vegas, and 1,472 in the rest of Nevada or other areas). The population within the 80 km (50 mi) radius of the Nevada Test Site is approximately 12,421. Minority population constitutes approximately 16 percent of the total. Figure 3-80 shows the racial and ethnic composition of the minority population within 80 km (50 mi) of the Nevada Test Site. Hispanics form more than 50 percent of the minority population.

The general characteristics of the low-income households residing within 80 km (50 mi) of the Nevada Test Site are presented in Figure 3-81. Low-income households are 48 percent of the total households.

The Nevada Test Site's fire protection capacity is structured to accommodate current mission requirements, with a self-contained firefighting department responsible for suppression and prevention. Other services include rescue, hazardous material response, training of fire personnel, fire prevention inspections, installation of all fire extinguishers at the Nevada Test Site, and fire prevention awareness programs. There is a mutual agreement between the Clark County Fire Department and all surrounding area departments to assist in any fire emergency when necessary (DOE, 1993a).

Health Care: The Nevada Test Site has a self-contained medical center that provides limited emergency treatment. Health care in the Las Vegas Area is provided through 13 full-service hospitals, with 3.44 hospital beds per 1,000 members of the population.

Education and Training: The Clark County school district provides education services for the employees who work at the Nevada Test Site. An average student/teacher ratio of 22:32 is reported for elementary school grades K-6 (DOE, 1993a). There are a number of vocational, training, and higher education institutions in the Las Vegas metropolitan area (DOE, 1993a).

Housing: Between 1980 and 1990, the number of housing units in Clark County increased by 84 percent. The increase in demand is attributable to the influx of retirees and other in-migrant population.

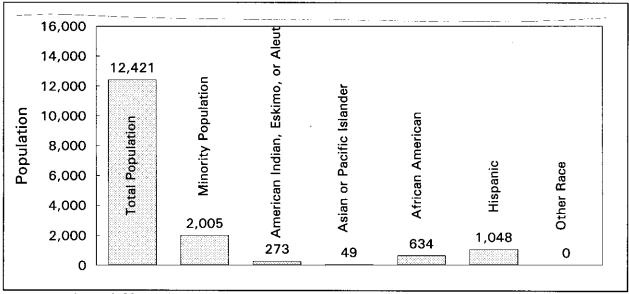


Figure 3-80 Racial and Ethnic Composition of the Minority Population Residing within 80 km (50 mi) of the Nevada Test Site

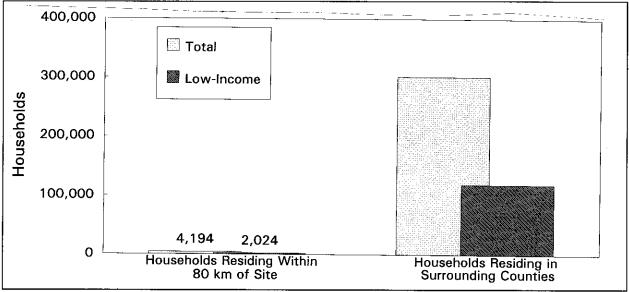


Figure 3-81 Low-Income Households Residing within 80 km (50 mi) of the Nevada Test Site

# 3.3.5.10 Historical, Archaeological, and Cultural Resources

People have inhabited the lands that comprise the Nevada Test Site for 12,000 years. The availability of the surface water was the primary determinant governing the location of past human occupation on these lands.

The Southern Paiute and Shoshone Native American tribes are known to have inhabited southern Nevada, including parts of what is now the Nevada Test Site. No known Native American resources are located on the Nevada Test Site (DOE, 1995c).